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THE BLOOD PICTURE IN KERATOMALACIA OF ADULTS *

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In continuation of the preliminary observations on anemia associated with keratomalacia,[1] the blood picture in thirty-five more cases was studied. The results of this study are submitted briefly in this paper.

In keratomalacia of infants, anemia has been reported only a few times. Recently, however, Hsu [2] found anemia in about half of his cases of children suffering from keratomalacia. It is still uncertain whether anemia can be produced by vitamin A deficiency alone or whether vitamin E deficiency must be present. In a previous paper on keratomalacia in adults,[1] two cases were reported among six in which anemia was found, while other possible causes, such as beriberi, scurvy, infectious diseases and tuberculosis, could be practically excluded. Unfortunately, the change in the blood picture after feeding with cod liver oil and during the healing of the eye disease could not be studied, as both patients left the hospital too soon. The anemia in these cases could probably be attributed to vitamin A deficiency, but this holds good only in severe cases and in those of long duration. After vitamin A deficiency in adults has reached the stage of keratomalacia, which in many cases is only after the deficiency has been present for about two or three months, it is possible that other factors enter that produce changes in the hematopoietic system. In a recently published paper [3] on the rôle of the various vitamins in the production of anemia, the conclusion is reached that "vitamin deficiencies in adults sufficient to cause keratomalacia, beriberi, scurvy, rickets, osteomalacia and tetany do not produce anemia. If anemia is present in these patients, it must be due to a deficiency of other substances or to some complicating factor such as infection."

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1. Pillat, A.: Does Keratomalacia Exist in Adults? Arch. Ophth. **2**:256 (Sept.) 1929.

2. Hsu, K. L.: Nutritional Keratomalacia, China M. J. **41**:825, 1927.

3. Keefer, C. S., and Yang, C. S.: The Rôle of the Various Vitamins in the Production of Anemia, Nat. M. J. China **15**:419, 1929.

Experiments on animals have not shown clearly whether vitamin A deficiency alone can produce anemia. Koessler, Maurer and Laughlin [4] maintained that anemia may be produced in rats fed on diets lacking vitamin A, whereas Simmonds, Becker and McCollum [5] claimed that vitamin E is responsible for the production of anemia in rats. Recently, however, they changed their former contention and stated that "there is no evidence that vitamin E has any rôle in iron assimilation." [6] This is further substantiated by recent writings of Sure, Kik and Walker,[7] who expressed their belief that in vitamin A deficiency in animals that has progressed to the ophthalmic stage the blood picture is affected by general inanition.

Since experiments on animals are not directly transferable to human beings, the blood picture in the following cases of keratomalacia in adults may be of interest in the question of its relation to anemia.

OBSERVATIONS

Of the fifteen cases with less than 75 per cent hemoglobin, seven seemed to show an intimate relation between the advanced stage of keratomalacia and anemia (cases 3, 6, 16, 18, 21, 26 and 29). Three (16, 26 and 29) of these seven cases occurred in children aged 3 years, 6 and 2 months, respectively. The others were in adults aged 19, 18 16 and 21. In all these cases a careful general physical examination including tests of the blood and stool revealed nothing to account for the anemia. Some of these patients when on a diet rich in vitamin A showed an increase of hemoglobin as well as relief from the keratomalacia. (In case 16, for instance, there was an increase from 70 to 94 per cent hemoglobin in seventeen days). There must therefore be a close relation between advanced keratomalacia and the blood picture, for no intercurrent infection nor any chronic disease can be held responsible for the anemia in these cases.

In two of the fifteen cases with hemoglobin below 75 per cent, the relation of keratomalacia to the anemia is uncertain. Case 1 showed a white blood cell count of 18,000 with 90 per cent polymorphonuclear leukocytes and only 10 per cent lymphocytes. The hemoglobin content was 65 per cent. Besides the keratomalacia, the patient had multiple

4. Koessler, K. K.; Maurer, S., and Laughlin, R.: The Relation of Anemia, Primary and Secondary, to Vitamin A Deficiency, J. A. M. A. **87**:476 (Aug. 14) 1926.

5. Simmonds, N.; Becker, J. E., and McCollum: The Relation of Vitamin E to Iron Assimilation, J. A. M. A. **88**:1047 (April 2) 1927.

6. Simmonds, N.; Becker, J. E., and McCollum: The Distribution of Vitamin E, J. Nutrition **1**:39, 1928.

7. Sure, Kik and Walker: The Effect of Avitaminosis on Hematopoietic Function: III. Vitamin E Deficiency, J. Biol. Chem. **83**:401, 1929.

Observations on the Blood in Keratomalacia

Case	Age, Years	Red Blood Cells	Hemoglobin, per Cent	White Blood Cells	Polymorphonuclears, per Cent	Lymphocytes, per Cent	Large Monocytes, per Cent	Eosinophils, per Cent	Basophils, per Cent	Comment
1	25	4,200,000	65	18,000	90	10	0	0	0	Multiple abscesses of scalp, most probably "dermomalacia"
2	1½	3,872,000	72	19,450	86	13	1	0	0	Atrophic nutrition; minimal rickets; died of bronchopneumonia
3	19	4,420,000	75	7,600	75	12	12	1	..	Wassermann reaction doubtful
4	21	3,844,000	70	12,200	81	10	9	..	..	Kala-azar; bronchopneumonia
5	21	4,560,000	80	8,400	75	12	13	..	..	Ascariasis
6	18	4,260,000	75	10,400	72	26	..	2	..	Ascariasis; beginning keratomalacia in the right eye; Bitot's spots
7	3	4,160,000	70	23,550	74	19	5	1	1	Died of bronchopneumonia
8	30	4,880,000	85	12,000	81	13	6	0	0	Tuberculosis of lungs
9	24	3,450,000	80	10,800	68	21.5	7.5	3	0	Keratosis pilaris; xeroderma
10	24	5,720,000	105	6,400	61	23	4	12	..	Parasites and ova not found; scabies
11	22	3,710,000	82	12,000	51	42	35	3	0.5	Ascariasis and hookworm
12	25	5,100,000	96	9,200	64	26	3	7	..	Hookworm
13	33	4,900,000	94	9,200	58	32	5	5	0	Ascariasis
14	26	3,630,000	56	8,100	86.5	9	4.5	0	0	Hookworm; ascariasis; paratyphoid; 9 days' illness
15	20	5,700,000	97	8,600	51	34	5	10	..	Recent and mild case of keratomalacia
16	½	4,532,000	94	13,750	..	..	..	..	..	Rickets (recent)
17	21	4,540,000	86	6,600	55	35	5	5	0	Parasites and ova not found
18	16	4,330,000	69	4,300	51	42	2	5	..	Ascariasis
19	21	4,200,000	80	13,600	79	14	2	5	0	Giardiasis and ascariasis
20	23	4,630,000	82	9,000	50	32	7	11	..	Hookworm
21	21	3,430,000	69	7,600	80	16	3	1	0	Phlyctenular keratitis increased by unilateral keratomalacia; hookworm; keratosis pilaris
22	21	4,920,000	100	9,000	70	18	4	7	1	Ascariasis
23	20	1,830,000	43	8,000	65.5	21.5	3	0	0	Died of pulmonary tuberculosis
24	23	4,630,000	92	6,100	68.5	21.5	2	8	0	Ascariasis
25	4	2,110,000	35	22,000	75	19	5	0	0	Died of empyema; atrophic nutrition
26	¼	2,210,000	45	39,100	54	38	6	0	0	Atrophic nutrition; infiltration of gluteal region
27	26	3,200,000	55	12,250	75	17	6	2	0	Died of pulmonary tuberculosis; ascariasis
28	26	1,180,000	73	5,450	64	28	6	2	0	Anemia; parasites and ova not found; hemorrhoids
29	2 mo.	3,620,000	75	5,000	..	..	..	..	..	Acute infection of the upper respiratory tract; beginning keratomalacia
30	21	5,200,000	91	11,800	61	25	6	8	0	Hookworm; scabies; keratomalacia only in left eye
31	24	4,900,000	90	14,800	55	41	3	1	0	Pulmonary tuberculosis; beginning keratomalacia only in the left eye
32	19	4,550,000	80	11,200	42	52	4	2	0	Beginning keratomalacia
33	..	4,800,000	100	6,500	69	30	1	0	0	Typhus, hookworm
34	24	4,700,000	100	13,600	52	32	8	7	0	Ascariasis
35	23	4,370,000	85	10,000	64	26	3	7	0	Beginning keratomalacia only in the right eye; skin: superficial ulcers of the lower extremities; acneform lesions; xeroderma

abscesses of the scalp and of other parts of the body, which were, however, of short duration. These abscesses were considered a simple decay of the skin,[8] similar to that of the cornea. The patient showed no symptoms of sepsis and no increase in temperature. With cod liver oil feeding, all the abscesses dried up within a few days without local treatment, while the keratomalacia also was quickly arrested. Since these abscesses were of short duration and healed so rapidly, it is safe to say that at least they were not the only cause for the decrease of hemoglobin to 65 per cent.

In case 2, a child aged 6 months, with severe bilateral keratomalacia, atrophic nutrition and 72 per cent hemoglobin, died of bronchopneumonia. Although the bronchopneumonia was of short duration and was probably not the only cause for the anemia, the origin of the anemia was obscure, and the case, therefore, must be excluded.

Six of the fifteen cases of keratomalacia showed marked anemia, most probably due to other debilitating disease. In case 4, a man, aged 21, with 70 per cent hemoglobin, for some time had had kala azar while suffering simultaneously from keratomalacia and bronchopneumonia. In case 14, a man, aged 26, with 56 per cent hemoglobin, had intercurrent paratyphoid A fever from which he recovered after nine days; in case 23, a man, aged 23, with 43 per cent hemoglobin, died of pulmonary tuberculosis; in case 25, a child, aged 4 years, with 35 per cent hemoglobin, died of empyema; in case 27, a man, aged 26, with 55 per cent hemoglobin, died of pulmonary tuberculosis, and in case 28, a man, aged 26, with 18 per cent hemoglobin, had bleeding hemorrhoids.

Several cases in our series showed that great importance cannot be attributed to intercurrent disease in the production of anemia. In case 7, a child, aged 3 years, who had 80 per cent hemoglobin, died of bronchopneumonia; in case 8 a man, aged 30, with 85 per cent hemoglobin, had severe tuberculosis of the lungs; in case 31 the patient had 90 per cent hemoglobin and severe tuberculosis of the lungs, and case 33 was that of a man with 100 per cent hemoglobin and typical typhus fever.

It is obvious that in this series there was no leukopenia. In only three cases was the number of white blood cells between 4,000 and 5,000 per cubic millimeter, and there was no explanation for such an observation. If we take Shelling's figure of from 6,000 to 8,000 leukocytes per cubic millimeter as normal, there were only ten cases that fell in this group. The commonest range, which comprised about 50 per cent of the series, was from 9,000 to 14,000—a moderate leukocytosis. Higher counts were few. The highest count, 39,000, was encountered in a case complicated by atrophic nutrition and a fresh infiltration of the gluteal region. A marked leukocytosis was usually associated with such septic

8. "Dermomalacia," Pillat.

complications as empyema and pneumonia, to which these patients usually succumbed.

An examination of the other figures in the accompanying table shows that there was a great variation in the differential count, with a tendency to lymphocytosis. The polymorphonuclears were reduced. The increase in the lymphocytes was frequently absolute. Lymphocytosis higher than 23 per cent, which is usually taken as a normal figure, was common, and counts of from 30 to 50 per cent were found in eleven cases.

In thirteen cases the number of eosinophils was above the accepted normal percentage of 3. This condition is frequently associated with such parasitic infections as ascariasis and hookworm and such skin diseases as scabies.

There was no notable change in the mononuclear leukocytes, and the basophils were not increased.

SUMMARY AND CONCLUSIONS

We conclude that in seven of thirty-five cases anemia was closely associated with keratomalacia, with no other cause for the anemia, and that in eight other cases the anemia may be explained by other chronic infectious diseases, such as tuberculosis, kala-azar, empyema and paratyphoid A fever. In several of the remaining twenty cases, however, the patients showed severe chronic infectious diseases such as typhus, typhoid and tuberculosis of the lungs, but they did not have anemia.

Whether vitamin A deficiency alone can produce anemia in human beings or whether other factors are responsible for it cannot be safely concluded from our series, since many of the cases of keratomalacia had reached a stage when general malnutrition and starvation perhaps played a rôle in the production of anemia, while many other cases were associated with other debilitating diseases, such as tuberculosis, kala-azar, paratyphoid and typhus, which can be held responsible for the anemia. We can, however, say that in the seven cases in which no general disease was found responsible for the anemia, there was no deficiency of vitamins B, C and D, or at least that it was not recognizable. In these cases the only recognizable feature in the eye and in the body was the vitamin A deficiency, which was severe, of long duration and easily cured, together with the accompanying anemia, by the ingestion of cod liver oil.

If cases of vitamin A deficiency in children and adults with anemia and without other complicating disease are followed closely as regards the blood picture, they will probably give further evidence as to whether vitamin A deficiency can cause anemia or whether in all cases, it only coexists with the anemia.

It may be concluded that when keratomalacia has progressed to a far advanced stage and has been further complicated by intercurrent infections, a state of serious disturbance in nutrition is obviously present. Anemia in these cases is usually marked. On the other hand, in cases in which the ocular lesion is mild and other complicating factors are absent, there is no appreciable change in the blood picture. A moderate leukocytosis ranging from 9,000 to 14,000 is found in 50 per cent of the cases.

ORAL INFECTIONS AND THEIR RELATION TO DISEASES OF THE EYE

FROM THE POINT OF VIEW OF THE ORAL SURGEON *

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My remarks must of necessity be chiefly clinical in character, as it seems almost impossible these days to be a clinician and a research worker at the same time. For many years, I have been calling the oral cavity the dirtiest cavity in the body, and have claimed that the maxillary bones and the mandible become infected more often than any bones in the body. The aforementioned statement caused little or no comment until last year, when it was challenged by Dr. Anthony Bassler, who took me to task at a dental meeting in Connecticut, and in his scholarly way called my attention to the fact that the intestines were much more unclean, and that they contained about 260 different kinds of "bugs," and he called them all by their proper names.

Of course, I felt disappointed because I knew at the time that in the mouth, there were only about 112 different types of bacteria. If Dr. Bassler had let me off at that, I should have stopped getting excited about the dirty mouth. But he went on to say that nearly all pulpless teeth became nonvital because the intestinal bacteria had a predilection for the pulps of teeth in which vitality was low, and that they found their way to the pulps of the teeth through the blood stream and caused the death of the teeth by their action. More teeth became nonvital in this manner than by the "old-fashioned" method of tooth decay entering the pulp, and the bacteria going through the cavity through the apex into the peridental membrane and thence into the cancellous bone of the alveolus.

I feel strongly that the teeth become infected most often in three ways: 1. In the intradental route the decay within the tooth involves the pulp and then the pulp canal to and through the apex of the tooth. This causes the true apical infection. 2. There is the peridental route under the gingivae that strips up the peridental attachment into the alveolus, and bacteria gaining access to the bone and lodging there. 3. Lastly there is the route through the blood stream. I believe that the two dental routes are used much more frequently than the third or hematogenous path, and that this fact can be proved by thousands of roentgenograms.

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ROUTES OF INFECTION

If one assumes for the moment that these dental routes are correct, can one not easily see why the teeth and the mouth are so important as the port of entry of bacteria into the system? If there are thirty-two teeth in a certain mouth, there are thirty-two chances of bacteria entering the pulps and gaining access into the spongy vascular bones of the jaws.

If there are thirty-two teeth in the mouth, there are also thirty-two and many more chances of the delicate gingival flap becoming traumatized by calcareous deposits and giving the bacteria in the mouth free access into the alveolus by stripping up the peridental membrane. Lowered resistance in the local tissue, of course, plays an important part in the aforementioned picture as does lowered general resistance. When the bacteria do enter the spongy, cancellous bones of the jaws, they find their proper nourishment and environment there, and they remain there for years and, in many cases, for the life of the patient. The question is how can the bones of the jaws be sterilized and how can this infection of the bones be prevented from causing some systemic disturbance?

This is the real crux of the dental situation as I see it. Pus under pressure, locked up in a spongy vascular bone, gives no trouble for years, but continuously and relentlessly breaks down the patient's resistance until the chemistry of the body has undergone certain changes that, as yet, are not fully understood, and secondary changes then take place in the blood and perhaps all other tissues including the eye.

In comparing the two methods by which the bone becomes infected, the intradental route through the dental canal produces the most serious of the three classes of infection, and a high percentage of all apical infections (when the teeth are removed without contamination) show pure cultures of *Streptococcus viridans,* hemolytic and nonhemolytic in character. The pure strain of *Streptococcus viridans* is so often obtained from pulpless teeth that it is not now considered important to make a culture from teeth in the routine way used formerly, as it is known that most pulpless teeth will give a culture of streptococcus. Cultures taken from periodontal lesions generally show a variety of bacteria including the staphylococcus, Vincent's spirilla, *Diplococcus catarrhalis,* spirochetes and streptococci.

It is almost impossible to get an uncontaminated culture from the end of a tooth without extracting the tooth most carefully under local anesthesia. Some experts may perhaps get a culture from the pulp canal. When a culture is required, I always prefer local anesthesia. With the patient under general anesthesia I am not so sure of removing the tooth from its socket without contamination with the increased flow of saliva

and the increased bleeding of the parts. The attempt to get a culture by penetrating the gum and alveolus and not removing the tooth, seems a waste of time to me, because in most cases it is impossible to get an uncontaminated culture, as one cannot sterilize the tissue through which one must pass. The question of pulpless teeth has not been settled as yet by the dental profession. My opinion is that nearly all pulpless teeth are infected, and that most of them cannot be made safe for the patients who are carrying them. Knowing that most pulpless teeth are infected, has one the right to say that because the patient is not having any trouble with them, and because the roentgenographic observations are negative the teeth can be watched and checked up from time to time, and when they do cause trouble, be removed? How much damage is done by that time? How can one tell when these teeth begin to cause trouble? How can one measure the amount of absorption that is taking place in the body from an infection that appears to be giving no trouble? Can one say that a young healthy person can carry infected teeth for five years, and that a person who is not so strong can carry teeth infected by streptococci for two years, after which time they should be removed? I think that this reasoning is dangerous, and I know of many instances in which it has proved fatal to the patient.

I am sorry to make the statement, but I feel, at this time that most pulpless teeth ought to be removed in a patient of about 50 years of age in order to reduce to a minimum the amount of virulent bacteria and their toxins that are present in the body, just as it is a correct procedure to cut down to a minimum the amount of bacteria in the milk or other food that one is to consume. This statement is, perhaps, rather radical, but it is based on many years' experience with infected mouths, and it is prompted by some sad experiences in the past of trying to save teeth that the dental surgeon could not render aseptic. For how can one say when a tooth is safe or sterile, and who can say when it is giving trouble or when it begins to give trouble from a systemic point of view? When one can definitely say that tooth infection is causing a certain systemic symptom, when one can measure the amount of disturbance that such an infection is giving, then and not till then can one temporize with the virulent bacteria of the mouth.

At this time, I should like to say that I think it is poor practice to curet infective alveoli of teeth after extraction. Price divided his cases of periapical infection into three classes according to the ability with which the body through its defensive mechanism is enabled to build up a granuloma around the apex of an infected tooth. In the first group are those cases in which there is considerable evidence of granulomatous formation with rarefaction of the bone, as shown by the roentgenogram.

In the second group are those cases in which there exists evidence of but little rarefaction of bone and consequently evidence of a poor

granuloma but a tendency to a condensation of bone in the vicinity of the infected apex. And in the third group are those cases in which the granuloma and the rarefaction of bone give way to a tendency toward a condensation in that position. Those are the cases in which the signs of the first group are being replaced by those of the second. Price found further that persons in group one had a definite immunity to rheumatic disease; in the second group, there existed a definite susceptibility thereto; whereas in the third group, there seems to have been an original immunity giving way to a susceptibility. He also found some interesting facts regarding the biochemistry of the blood of persons in these three groups, and he pointed out that the building of a granuloma was a defensive process. In those persons in whom the defensive mechanism was efficient, there existed an immunity to rheumatism, and in those in whom it was deficient, a susceptibility.

Some years ago, the great surgeon Dr. Joseph A. Blake asked me not to curet the alveolus after extracting an infected tooth. He said: "You know, Dunning, it has taken me many months to build up a barrier around that tooth, and I do not want it broken down at once, so that the bugs at the apex of that tooth can have free access into the walls of the newly formed wound." Ever since this meeting with Dr. Blake I have discontinued the use of the curet after extraction of teeth, except in certain more or less rare cases.

I believe that it is a dangerous practice ruthlessly to destroy at once the defensive barrier that nature has built around the apex of a diseased tooth, as it is possible by this procedure to let loose into the system many dangerous bacteria and their toxins. From my talks with Dr. Roseman, I feel that he concurs in this opinion. It is a much safer procedure to swab the postextractive alveoli with equal parts of half-strength iodine and glycerin, to keep the wound open and to let nature throw off the granuloma or limiting membrane in her own manner. I also believe that it takes a long time for nature to throw off bacteria from an infected postextraction wound. Many times bacteria are not eliminated from the jaws by the mere extraction of the teeth. Some writer stated that from 20 to 40 per cent of edentulous mouths harbor residual areas of infection. Infected root ends and cysts play an important rôle in the preceding picture.

REVIEW OF THE LITERATURE

I have endeavored to give my idea of the oral side of the picture of infections that have a bearing on the subject. To say that my knowledge of the diseases of the eye is limited is but putting it mildly. In the preparation of this paper, I have been greatly helped by Dr. Conrad Berens, who kindly placed his splendid library at my disposal. The literature has been examined carefully and appears to me to be teeming

with evidence that the infections of the mouth play an important rôle in connection with ophthalmic diseases. I could relate many cases reported in the writings of De Schweintz, Berens, Rosenow, Wilmer, Price, Gardner, Bell, McCarltry, Bulson and others that would go a long way in convincing one that infections of the mouth have a great influence on many systemic diseases in general and on the diseases of the eyes, which at present are of especial interest. The recitation of many of these cases would be out of place, but it might be of interest for me to review some of the literature written recently regarding focal infection. In an article written by Dr. Rosenow and Dr. Mickel, and read before the American Society of Clinical Pathologists in June, 1928, the following was said:

> The large number of instances reported in the literature during the past fourteen years in which causal relationship between focal and systemic disease is indicated by the clinical history and improvement or disappearance of the systemic condition following the removal of foci of infection, such as occur commonly in tonsils, teeth, sinuses, and intestinal tract, prostate and cervix, would alone be convincing if it were not that a considerable number of patients fail to improve following removal of one focus or more. Such failure, however, should not be interpreted as nullifying the principle involved, for there are good reasons why the clinical improvements may not follow the removal of one or more foci of infection. The disease may have existed for so long a period as to produce irreparable harm or it may have become so thoroughly established as to continue independent of a primary focus. The particular focus or foci removed may not have had etiologic significance at the time of removal, or even before, or, as in the case of dental or tonsillar foci, the operative procedure may have been inadequate. The responsible focus may have been overlooked because so often symptomless. Not all systemic diseases are expressions of focal infection. Clinical improvement occurred with such regularity and was so marked, however, following removal of foci of infection in those cases in which the results in animals in our experiments had demonstrated the presence of the causative organisms, as to leave no doubt of the great value of this procedure in suitable cases.

Dr. W. L. Benedict of the Mayo Clinic read a paper before the Colorado Congress of Ophthalmology and Oto-laryngology in July, 1920, entitled: "Value of Dental Examination in the Treatment of Ocular Disorders." I should like to quote him at length, as his statements appear to me to be clear and much to the point. He said:

> The influence of dental sepsis on diseases of the eye has been investigated by many workers since Lang, in 1913, published his observation on the subject, and a large number of case reports have been published which demonstrate the value of examination of the teeth in treating diseases of the eye.
>
> Carefully observed cases of periostitis, orbital abscess, iritis, and uveitis that can be definitely ascribed to dental sepsis have been recognized and described. While the exact process of extension from the teeth to the eyes was in many instances not known, the improvement of the eye conditions that followed correction of the disease about the teeth was considered sufficient evidence that a close relationship exists. When a rather severe chronic corneal ulcer that had failed

to yield to common methods of treatment healed readily after the extraction of a diseased tooth, when chronic or recurrent iridocyclitis became quiet following the removal of infected teeth or the treatment of pyorrhea, other probable causes of the disease having been eliminated, the conclusion was justified that the disease of the eye was due to disease about the teeth, or that toxins absorbed from suppurative foci about the teeth contribute to the chronicity of the ocular affection.

That pyorrhea or partly decayed teeth in the mouths of persons suffering from disorders of the eye do not more frequently appear to have an influence on the course of the disease has been used as an argument against the causal relationship of dental and ocular affections, but if we more fully understood the characteristics of the organisms that produce disease, and the changes in virulency of the organisms and variations in the strength of the resistance which nature puts up as a barrier to the spread of the disease, we probably could more easily account for the few metastatic infections, and arrange a more satisfactory system of prophylaxis.

METHODS OF TRANSMISSION

Eyes, previously healthy, may become diseased by the transmission of organisms from diseased teeth in three ways:

1. Direct extension through bone. The tooth socket becomes the seat of an infection that destroys the bone of the upper jaw, and through that directly affecting the orbital walls, finally producing an orbital cellulitis or retrobulbar neuritis. Such extensions of the disease process about the teeth seldom affect the interior of the eye, but are found as abscesses of the lids particularly the lower abscesses of the sinuses, emboli, abscesses of the frontal lobe with atrophy of the optic nerves, and periostitis.

2. Direct extension of the process along the periosteum of the malar bone invading the orbit and giving rise to processes similar to those mentioned.

3. Transfer of organisms from the focus at the tooth to the eye by the blood stream. This is the most frequent means of transfer of infection from the teeth to the eyes, and consequently is the most important.

Dr. Benedict continued:

It is often difficult to demonstrate that infections about teeth are responsible for any individual case of eye disease. Extraction of affected teeth does not always yield beneficial results. But it should be remembered in this connection that possibly all sources of organisms responsible for the eye affection were not eradicated with the extraction of the teeth, that organs other than the eye have been invaded and become secondary foci for the production of the same strain of organism, or that even after extraction a septic pocket may have remained in the diseased jawbone. Recurrent iritis, keratitis, uveitis, and transient disturbances of ocular motility occur from these secondary foci after the removal of infected teeth and are to be combated by the use of autogenous vaccines.

Some forms of eye diseases that formerly were believed to be due to autotoxemia, injury, blood disease, rheumatism, or were idiopathic, have been demonstrated to be due to the actual presence of bacteria carried to the eye from suppurative foci about the teeth or tonsils. Rosenow has shown that organisms taken from diseased teeth are capable of producing disease of the eye when injected directly into the blood stream of animals; and furthermore, that such organisms have a selective affinity for certain structures of the eye and that within limitations this selective affinity is characteristic of the strain and is maintained through several cultural transplants of the organism. He has demonstrated that organisms grown from the tooth of a person suffering from muscular

rheumatism produce iritis in the eyes of animals as well as hemorrhages in the skeletal muscles.

The barrier that nature erects in defense of the eye may be effective against a specific strain of organism, and since organisms about the teeth multiply in kind as well as in number the fact that an eye becomes diseased in a person whose mouth has harbored pus-producing foci for years indicates that his barrier has been lowered, or it may mean that a new organism has been introduced against which no barrier has been erected.

Attacks of eye disease produced through dental sepsis may be of any degree of severity. Mild attacks of conjunctivitis or iritis may occur which amount to no more than a transient hyperemia of the conjunctiva, or a slightly troublesome photophobia. A rapid succession of mild attacks extending over a period of several years has been demonstrated to be due to periapical infection. The iris and choroid are more often attacked by organisms from apical infection although optic neuritis, scleritis, keratitis, and conjunctivitis are reported to have been found.

Since the introduction of a dental section at the Mayo Clinic, the relationship of diseased teeth and lesions of the eye has been carefully studied. Definite relationship has been established in a number of cases of acute inflammatory eye lesions and similar lesions produced in animals by means of methods described by Rosenow. Autogenous vaccines made for the patients have been used to supplement the treatment with highly gratifying results. In many conditions of the eye other than inflammation from infection, the dental examinations have given valuable aid and results which are encouraging and warrant further investigation.

TRACHOMA AND AVITAMINOSIS*

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The isolation of *Bacterium granulosis,* and with it the production of lesions of the eye reminiscent of trachoma in monkeys, which was announced by Noguchi in 1928,[1] has presented a new method of approach to the etiology of trachoma. Several investigators, Finnoff and Thygeson,[2] Tilden and Tyler,[3] and Stefanova and Asarowa[4] among others, have already reported the presence of *Bacterium granulosis* in material taken from patients with the disease. McCartney,[5] on the other hand, using the Noguchi procedure, failed to isolate the organism from a series of cases of trachoma, and a recent communication from Morax[6] also reveals inability to recover the microbe from a series of eleven cases.

Noguchi, and Finnoff and Thygeson, reported the slow development of folliculosis in monkeys following conjunctival inoculation with their strains of *Bacterium granulosis.* This proceeded to scarring in some of Noguchi's animals, with the infection spreading to the uninoculated eye in a few instances. Ophthalmologists, however, are as yet by no means agreed that the Noguchi organism is the sole incitant of trachoma. A careful analysis for and against the etiologic significance of *Bacterium granulosis* by Wilson,[7] which appeared recently, reflects current opinions. He isolated the Noguchi organism, but with much difficulty, and in only a small percentage of cases. This may be construed as a tribute to Noguchi's skill in making the initial discovery. Serologic reactions with *Bacterium granulosis* and serum from cases of trachoma were negative: the impression gained is that the serum of patients with trachoma does not contain agglutinins of significant potency. Wilson stresses the spon-

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1. Noguchi: J. Exper. Med. **48**:1, 1928.
2. Finnoff and Thygeson: Am. J. Ophth. **12**:651, 1929.
3. Tilden and Tyler: Science **71**:186, 1930.
4. Stefanova and Asarowa: Klin. Monatsbl. f. Augenh. **83**:839, 1929.
5. McCartney: Brit. J. Ophth. **3**:586, 1929.
6. Morax: Rev. internat. du trachome **7**:2, 1930.
7. Wilson, R. P.: Rev. internat. du trachome **5**:76, 1929.

taneous occurrence of follicular conjunctivitis in monkeys, dogs and cats. This must have important bearing on the evaluation of inoculations into animals. Thus far, however, *Bacterium granulosis* does not appear to have been detected in spontaneous folliculosis of animals.

Many observers have emphasized the importance of predisposing and contributory factors, dust, flies, vitamin deficit and others, in the causation of the disease. Of these, deficit of vitamin A, leading to keratomalacia in extreme instances, would appear quite reasonable. The occurrence of trachoma among the nomadic tribes of American Indians, whose dietary habitus might predicate deficiency of vitamin A, seems to lend theoretical support to this assumption.

The observations recorded here are a brief résumé of experiments designed to test the effects of vitamin A deficit per se as a predisposing factor to infection with the Noguchi organism. As the results apart from the isolation of *Bacterium granulosis* from the trachoma material are entirely negative, the narrative will be brief.

White rats, which are readily deprived of vitamin A, were selected for the purpose. Professor Farmer provided animals in the proper state for study. The cultures of *Bacterium granulosis* used were three: one from Dr. Finnoff, a Noguchi culture obtained through Dr. Olitsky of the Rockefeller Institute and one freshly isolated by us from a case of trachoma. The organisms agreed in essential details of morphology, staining and fermentation reactions. In addition, fresh trachoma material, from which our organism was isolated, served as an inoculum for a few animals. Three series of experiments were made: series A, animals deprived of vitamin A for thirty days and exhibiting keratomalacia before inoculation; series B, animals deprived of vitamin A for ten days before inoculation (these animals, and those of series C were kept on a vitamin A-free diet for an additional eighteen days), and series C, animals deprived of vitamin A for ten days and then inoculated, first with cultures of *Bacterium granulosis* previously grown on rat blood agar and then with cultures grown on Noguchi leptospira medium. As these inocula were ineffective, a single inoculation with *B. pseudotuberculosis-rodentium*[8] was made (which caused transitory inflammation) and then a reinoculation with *Bacterium granulosis*. Finally, these attempts having failed, the animals received instillations of streptococci, obtained from trachoma material, and a sarcina-like organism from the same source. Reinoculation with *Bacterium granulosis* failed to induce discernible changes in the eyes of the animals. The C series, it will be noted, were resistant to infection with a total

8. This culture was obtained from Professor von Herrenschwand, Innsbruck, Austria.

of four distinct bacteria, including *Bacterium granulosis*. A protocol from each series will indicate the procedure.

One member of each group of animals receiving microbic or trachomatous inocula had its conjunctiva scarified with a sterile needle prior to instillation of the inoculum. The remainder were unscarified.

Series A.—Twelve rats, deprived of vitamin A for thirty days, had keratomalacia. Three were uninoculated controls, three received fresh trachoma material,[9] three received the Finnoff culture and three the Noguchi culture. Only one inoculation was possible with the trachoma material. It was necessary to give cod liver oil three days after the experiment started. Inoculations with *Bacterium granulosis* (Finnoff and Noguchi) were performed December 10, December 16, and December 23. The results were entirely negative.

Series B.—Twelve rats were placed on vitamin A-free diet ten days prior to, and eighteen days after, inoculation. Cod liver oil and a regular diet then replaced the vitamin A-free regimen.

Three animals, uninoculated, were controls. Four received the freshly isolated strain of *Bacterium granulosis,* three received the Noguchi culture, and two the Finnoff culture. Inoculations were given on December 23, December 30 and January 6. The inoculum was from a heavy growth of the organism in the Noguchi leptospira medium in each instance. The results were entirely negative.

Series C.—Twelve rats were placed on a vitamin A-free diet ten days prior to, and eighteen days after, inoculation. Cod liver oil and a regular diet then replaced the vitamin A-free diet. Three animals uninoculated were controls. Three received the freshly isolated strain of *Bacterium granulosis,* three the Finnoff culture mediums and three the Noguchi culture.

Three inoculations were made with cultures grown on rat blood agar, followed by three inoculations with cultures grown in the Noguchi leptospira medium, one with a culture of *B. pseudotuberculosis-rodentium* and one each with a streptococcus and a sarcina obtained from trachoma material.

Inoculations with rat blood agar cultures were given on January 13, 16 and 23; inoculations with leptospira medium cultures were given on January 29, February 5 and February 10. (Regular diet replaced vitamin A-free diet January 30). Inoculation with *B. pseudotuberculosis-rodentium* was given on February 24; inoculation with the aforementioned streptococcus, on March 3, and inoculation with the aforementioned on April 4. The results were negative.

COMMENT

The experiments herein recorded were planned to test the rather common belief that deprivation of vitamin A, especially in that advanced state leading to keratomalacia, may be a predisposing factor in the development of trachoma. The experimental animal selected, the white rat, is readily deprived of vitamin A. Keratomalacia is a frequent, but by no means inevitable, sequel to this deprivation. Hence from this aspect, the white rat is well suited for this particular phase of the problem. It must be admitted, however, that the white rat may have a

9. The freshly isolated culture of *Bacterium granulosis* used in series B and C was obtained from some of this material.

degree of resistance to the trachoma virus that transcends even the effects of a prolonged starvation of vitamin A. Also, the etiologic relationship of *Bacterium granulosis* to trachoma is not as yet agreed on; hence it cannot be dogmatically asserted that these experiments are in any manner conclusive.

Numerous unsuccessful attempts to induce trachoma in man by applying trachoma material directly on the eyes of blind persons are recorded. However, Taboriski [10] stated that he had induced trachoma by this procedure. In spite of the positive results of Taboriski and others, the total evidence indicates that the implantation of trachoma material in the eyes of man is, or may be, insufficient of itself to incite trachoma. Nevertheless, some interest must attach to the wholly negative results attending the instillation of fresh trachoma material (from which the *Bacterium granulosis* was isolated) into the eyes of white rats thoroughly deprived of vitamin A. In the light of the statements that dogs, cats and monkeys [7] may spontaneously contract folliculosis, it would appear that the lack of success in inducing even a transitory reaction with fresh trachoma material after deprivation of vitamin A is suggestive that such deprivation per se is not necessarily a factor in trachoma infection. This, however, is not to be construed as an argument against the statement that deprivation of vitamin A is a contributory cause.

10. Taboriski: Arch. f. Ophth. **123**:140, 1929.

SOME OBSERVATIONS IN REGARD TO GLAUCOMA SIMPLEX *

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For a long time it has been my opinion that too much stress has been laid on the mechanical theories as to the cause of glaucoma. Most of these theories have been formulated from the anatomic changes found in blind eyes and in those that had been subjected to inflammation. In other instances the theories have been purely hypothetical. Many of them have been handed down from one teacher to another and, as so often is the case, accepted without question.

For the past few years I have been measuring the intra-ocular tension in all patients who came to the office, with the exception of young children and those with certain inflammatory conditions, and I have had the opportunity of making some intensely interesting observations. I have found eyes in which there was increased intra-ocular tension without other symptoms of glaucoma, and have been able to watch these eyes for a long time before such have developed. I have also studied the anatomic details of eyes in which the intra-ocular tension was within the accepted physiologic limit in order to determine what, if any, influence was exerted on it by differences in the conformation of apparently normal eyes. When normal eyes are mentioned in this paper, I mean those that have no demonstrable diseased conditions other than refractive error. From my studies I have come to the conclusion that increase in intra-ocular tension can exist for a long time without diminution of direct vision, gross changes in the fields, glaucomatous cupping of the optic disk or other of the classic symptoms of glaucoma; but unless remedial measures are used to bring it within normal limits, these secondary changes inevitably and ultimately occur. In this connection it is interesting to quote from H. M. Traquair's book, "An introduction to Clinical Perimetry."

> Since the field changes are the result of the glaucomatous process, it is evident that their detection, even in their earliest form, does not indicate the onset, but the presence of the disease. The recognition of glaucoma in what may be called its preperimetric stage is developing, and, as our knowledge and skill in this respect increases, we may expect to find that the elicitation of the field changes is mainly useful in supporting and confirming, rather than in initiating, the diagnosis.

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The measurements that I have made have all been on private patients, under the most ideal conditions. This means a great deal, as the personal equation enters into the measurement made to determine intra-ocular tension, although it is supposed to be a purely mechanical procedure. The earlier teaching was that with the advance of years the intra-ocular tension increased; or, as it was then expressed, the eye became harder or stiffer with years. After the tonometer had been used for some years, the opinion was advanced by certain authoritative writers that the contrary was true; that is, the tension was less in old than in young persons. I believed this until I began to tabulate my records, when I was surprised to find that there was practically no difference between the intra-ocular tension in any decade of life and that of any other decade from 15 to 80 years.

CLINICAL OBSERVATIONS

The measurements were tabulated in decades, except the first, and the average per hundred was found to be as follows:

Years	Right Eye	Left Eye
15 to 20	17.54	16.98 mm.
20 to 30	17.98	17.26 mm.
30 to 40	16.50	16.06 mm.
40 to 50	16.94	16.24 mm.
50 to 60	18.54	17.70 mm.
60 to 70	17.72	17.08 mm.
70 to 80	16.94	17.10 mm.

All measurements were made with the original Schiötz tonometer and were selected indiscriminately from approximately 5,000 measurements.

It will be noted that the average was well below 25 mm., which is given as the upper physiologic limit by Schiötz. The tension apparently was not influenced by the size of the corneas, the eye, or the pupil, the size and shape of the physiologic cup or the state of the refraction. It was not influenced by the presence of high or low blood pressure or by arteriosclerosis. It was unaffected by race. Small eyes, or eyes with corneas of short diameter, are said to be subject to glaucoma. As stated before, such eyes showed no higher tension than larger ones in the examinations done as a routine measure. It is possible that when the exciting cause of glaucoma is active the small eyes may be more readily affected, but the size of the eye or the diameter of the cornea is not causative of itself.

The increase in size of the crystalline lens, which occurs with age, is given as one of the causes of glaucoma. I have measured the tension in hundreds of older persons and have had the opportunity to remeasure it numbers of times when they returned for periodic examinations,

and I have found no elevation of tension and very little variation in it from time to time. As in case of small eyes, given the exciting cause, eyes with large lenses may be more susceptible. In other words, causative factors might be active in eyes and not produce rise in tension if they did not have these anatomic peculiarities, but the size of the lens or of the eye of itself does not produce glaucoma. If such were the case more old persons and persons with small eyes would show increase in tension. On the contrary, one finds increase in tension occurring in persons with eyes and corneas of average size, in those with corneas larger than normal, in persons in middle life, in young adult life, in adults and, occasionally, in children.

Much stress has been laid on the formation of the disk and the intra-ocular end of the optic nerve, especially the size and strength of the lamina cribrosa, as a factor in glaucoma. Certain types of disks are assumed to have influence on the glaucomatous process and to be affected by increase in intra-ocular tension more readily than others. I do not believe that so-called variations in the size of the fibers of the lamina cribrosa or that the shape and size of the cup have anything to do with it. Unfortunately, the observations from which these deductions have been reached were made on eyes that had undergone great change, the result of the disease, before removal; what was seen was the effect of the glaucoma, and was not the glaucomatous process. So it would be impossible to state what the character of the lamina had been before being attacked by the disease.

It is generally accepted that the glaucomatous cupping of the disk is due directly to the increase of intra-ocular tension, and that the pressure causes the lamina cribrosa to yield and the surface of the disk to recede sufficiently to produce the characteristic ophthalmoscopic picture. A number of writers have stated that they have seen the glaucomatous cup disappear after relief from increased tension, either from the use of myotics or following operations. In spite of the distinguished names that sponsor these statements, I cannot reconcile myself to believe that this occurs, or that glaucomatous cupping of the disk is a primary effect of increased pressure, and that once formed it can disappear. It is my belief that the glaucomatous cupping is a secondary effect of increased tension, and that it can occur only after destruction of part of the substance of the optic nerve.

In order to appreciate these facts it will be necessary to recall certain anatomic details with which all are familiar. If one will look at a longitudinal section of the optic nerve at its entrance into the globe, it will be seen that the posterior opening of the scleral canal is larger than the anterior; at the level of the anterior third of the sclera will be seen

bands of connective tissue fibers that pass from one scleral border of the canal to the other, at right angles to the nerve. These fibers compose the connective tissue lamina cribrosa. It is here that the nerve fibers lose their myelin sheathes and the diameter of the nerve is diminished.

Thenceforward the fibers exist as naked axis cylinders. In front of the connective tissue lamina at the level of the choroid will be seen other bands of fibers at right angles to the nerve, which stretch from one choroid border of the canal to the other. These are more delicate in structure and stain differently from the fibers of the connective tissue lamina. They are glial fibers and constitute the glial or choroid lamina cribrosa, and act as supporting tissue for the nerve fibers (the naked axis cylinders) in front of the first lamina. Throughout the canal it will be seen that its lumen is completely filled by nerve. In order to obtain the ophthalmoscopic picture of glaucomatous cupping in which the blood vessels disappear as they pass over the margin of the disk to reappear at the bottom of the cup, it would be necessary not only to push the nerve tissue backward, but to compress it against the lateral walls of the canal sufficiently to permit the blood vessels to bend over and disappear under the sharp edge of the anterior opening of the scleral canal.

I do not believe that this is possible as long as the nerve tissue is intact. It would seem a mechanical impossibility to dispose of the amount of nerve substance filling this portion of the canal in such a manner. Even if the scleral lamina gave way, there would still be the mass of fibers and glia in advance of it to be disposed of before the vessels could be pressed against the walls of the canal. Before this can happen a certain amount of the nerve substance must be destroyed, and this is accomplished by atrophy of nerve fibers and glial lamina. This atrophy, of course, is the result of pressure, but whether the destruction takes place, as is generally stated, as the fibers pass over the "sharp edge of the scleral opening," or whether it is due to other mechanisms, such as compression of the blood vessels of the retina, is open to question. If one accepts the theory that the nerve fibers that arise from the periphery of the retina are the most superficially placed as they enter the disk, it is difficult to reconcile the defects in the field of vision with the theory of destruction at the margin of the disk, as they would presumably be less liable to injury than the underlying fibers. If this explanation of the formation of the glaucomatous cup is correct, it is a sequel of glaucoma and not a symptom, and it seems wrong that it should be necessary to await its development before making a diagnosis of glaucoma.

To illustrate how persistently ophthalmologists cling to the old mechanical ideas of glaucoma, it is interesting to note how since Profes-

sor Thomson announced his interesting theory of the pump action of the ciliary muscle on the scleral spur and pectinate ligament, it has been suggested that persons with glaucoma read a great deal in order to keep the ciliary muscle in action, this being supposed to keep open communication between the anterior chamber and the canal of Schlemm, and thus promote the flow of aqueous outward. Theoretically, this is interesting, but its advisability is questionable. In the later stages after the adhesion of the root of the iris to the cornea it would be of no avail, and earlier in the course of the disease it would seem more rational to allow the ciliary body as much rest as possible. It is interesting to note here that the canal of Schlemm often remains open in eyes with advanced glaucoma, even after communication with the anterior chamber has practically been shut off.

It is quite generally believed that glaucoma is not a purely local disease of the eye, and that irrespective of what takes place within the eye to cause the rise in tension, there must be some abnormal condition elsewhere in the body before these intra-ocular changes occur. I am becoming more convinced that among other initial causes of glaucoma there may be some form of focal infection, located in diseased teeth, nasal accessory sinuses, the prostate, the tonsils or the intestines. How these focal infections act, directly or indirectly, one cannot with present knowledge venture to suggest. It is too soon to speak definitely of the influence of disturbances of the endocrine glands, but I have several cases under observation in which they apparently are the exciting cause, especially the pituitary body. However, the number of patients and the length of time over which they have been observed are not sufficient to warrant any definite conclusion.

From my observation of cases in the early stage, it seems that if, as Fuchs says, "all the essential symptoms of glaucoma can be accounted for as being results of increased pressure," it is incumbent on ophthalmologists to discover its presence before they occur and to direct attention to a study of the patient generally in order to determine the existence of disease conditions that might be considered as etiologic factors. I believe that if one is ever to learn anything of the nature and causes of glaucoma it will be done in the early stages.

It is contended by some that an increase in intra-ocular tension alone, without cupping of the disk, changes in the anterior chamber and visual fields, is not glaucoma. I think that this may be due to the different interpretations of the term "glaucoma." I accept Colonel Elliott's definition that "the term glaucoma is the equivalent of a hypertension of the eye leading to the production of morbid phenomena." By this I do not mean that such a diagnosis should be made on finding the intra-

ocular tension slightly raised at one examination. But if at repeated examinations made over a number of days or weeks it remains above the physiologic limits, I believe that one is justified in doing so, even though none of the other classic symptoms is present. For although, as stated before, I have watched eyes with no other symptoms than hypertension for months, ultimately and inevitably the others followed.

COMMENT

Today there is an increasing demand for the early recognition of glaucoma. Possibly more is being written along this line of thought than at any time in the history of the disease. In spite of this, very little new in the way of diagnostic methods has been offered. Outstanding among these is the splendid work on light minimum done by Dr. George Derby. But, as he stated in his paper before the Section on Ophthalmology of the American Medical Association in 1928, while the apparatus was admirably designed for use in a hospital such as theirs, it was too bulky and too complicated for ordinary clinical work. Quantitative study of the central visual field has its place in the examination of patients suspected of having glaucoma, but one would not undertake to make this test in the course of routine examination except in eyes showing some abnormality. What is needed is some measure that can be included in the routine examination without consuming too much time and without being too complicated. At present I know of nothing that fulfils these requirements other than routine tonometric measurements. If one is systematic in one's work, not more than a few minutes need be added to the time of the examination. After all, it is universally conceded that the increase in tension precedes all of the classic symptoms, even including changes in the light minimum; therefore, if looked for intelligently, it would, in the majority of cases, be found. The fact that it may be intermittent in the early stages and at times absent is no more reason for not making tonometric measurements than it would be to exclude urinalyses or blood pressure measurements in general examinations because albumin or casts are not always present in disease of the kidney, or because blood pressure is not consistently abnormal.

The contention that the tonometer does not make measurements of intra-ocular tension sufficiently accurate to satisfy laboratory methods should not prevent its use, for it is far more sensitive than the finger as used in palpation, and for practical purposes gives information of value.

PERSISTENT POSTERIOR FIBROVASCULAR SHEATH OF THE LENS CAUSED BY FETAL IRITIS*

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When the fibrovascular sheath which normally surrounds the fetal lens until the seventh month fails to disappear in the central part of its anterior portion, the condition is known as persistent pupillary membrane. When the posterior portion remains, the anomaly is referred to as persistent posterior fibrovascular sheath.

The case presented is of interest for two reasons; (1) faulty diagnosis, the eye having been removed for suspected glioma; (2) the congenital anomalies found are associated with definite inflammatory changes in the adjacent structures. Literature in proof of hereditary influence in the production of such congenital defects as colomboma of the iris, aniridia, cataract, ectopia lentis, etc., is not wanting, but possibly on account of the infrequency of occurrence, no such influence has been attributed to retained fibrovascular sheaths. M. T. MacKlin, in 1927, cited one interesting case in which the father had aniridia and his thirteen children all showed the same defect. Francis Lane, in 1912, presented five cases of persistent fibrovascular sheath, one of which showed in addition a few strands of persistent pupillary membrane. Two of these cases were observed clinically, and because of the fact that in one patient the posterior fibrovascular sheath with the attached hyaloid artery could be seen with the ophthalmoscope, and the other showed definite congenital changes in each eye, a reasonably correct diagnosis was made, and the eyes were not removed. The other three cases were observed by him in the laboratory, the eyes having been enucleated because intra-ocular tumors were feared. Sanford Gifford, in 1923, described a case in which an eye of a child aged 3 years was removed because of the possibility that a glioma was present. Laboratory examination revealed a well marked persistent posterior fibrovascular membrane. He gave a good résumé of the cases that had been reported until this time. Since slit-lamp examination has become routine in many clinics and offices, a number of cases have been discovered that show only fragmentary remnants of congenital sheaths. No evidence of inflammation was found in any of these eyes.

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* Read before the Chicago Ophthalmological Society, March 17, 1930.

Some of the sections pertaining to this case were sent to Prof. Adalbert Fuchs of Vienna, who reported on them as follows:

I agree with you that the slides show congenital changes. I think, where posterior synechia and capsular cataract are present, one can never exclude foetal inflammation; it is also my belief that a large number of ocular malformations are such, on a basis of intra-foetal inflammation. I have seen this, especially, in cases of hereditary syphilis in which it is easier to prove than other cases.

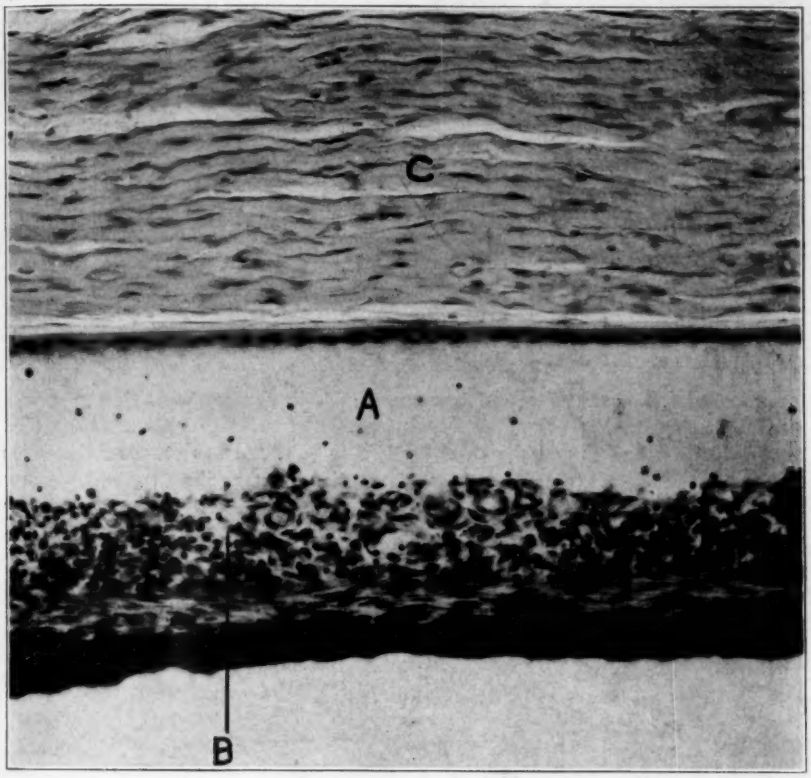

Fig. 1.—*A*, a few lymphocytes are seen in the anterior chamber; *B*, marked infiltration of lymphocytes in the anterior layers of the iris, and *C*, cornea; × 200.

REPORT OF THE CASE

A girl, aged 4 months, was brought to Rush Medical College by her mother for examination. The latter stated that she believed the child to be blind in the right eye, as she had noticed a gray film in the pupil since birth. On examination the right eye seemed slightly smaller than the left. The cornea was clear and approximately the same size as the left. The anterior chamber was very shallow. The iris was discolored and either atrophied or undeveloped. Three engorged vessels were seen close to the anterior surface, running radially to the pupillary

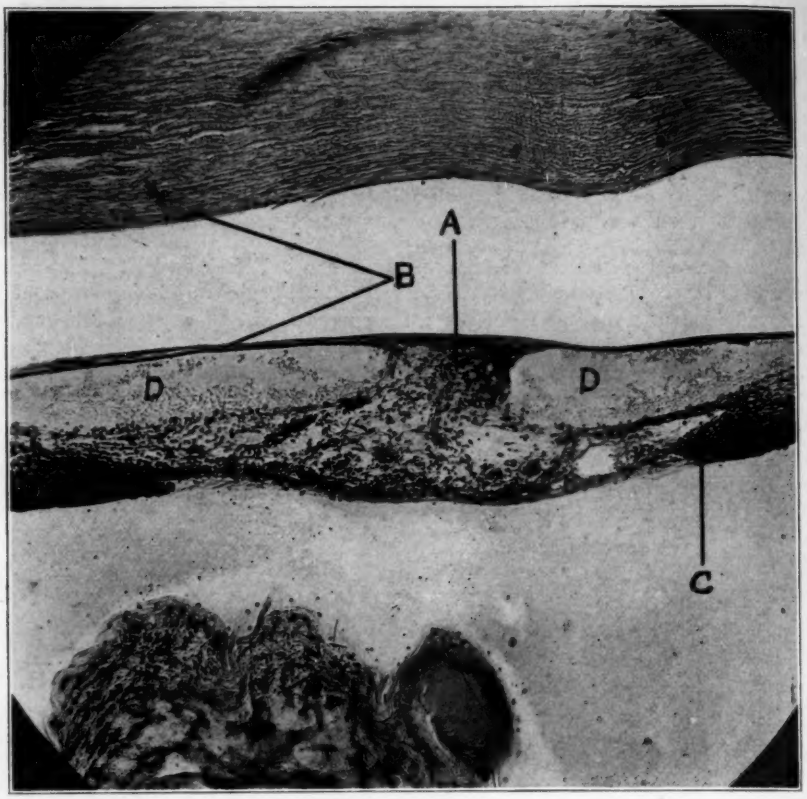

Fig. 2.—*A*, fibrovascular pupillary membrane in contact with *B*, the cornea (Descemet's membrane artificially separated), in front. Laterally it is attached to the shelf of the iris and the pupillary border (*C*), and has produced entropion of the iris (due to postinflammatory contraction of the fibrous tissue, pulling the iris stroma toward the center in advance of the pigment layer); *D*, anterior chamber; × 60.

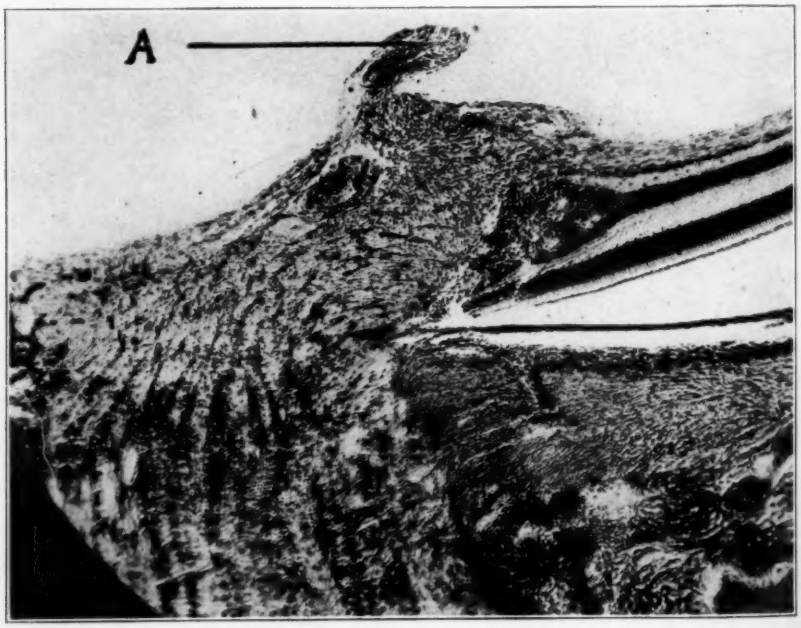

Fig. 3.—*A*, section of hyaloid artery extending from the optic nerve head; × 65.

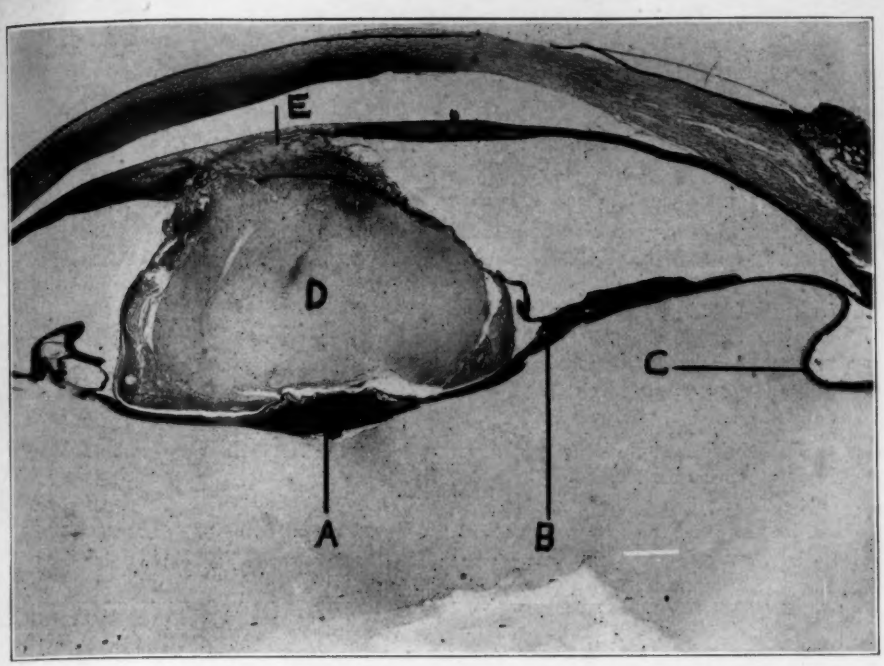

Fig. 4.—*A*, posterior fibrovascular sheath with a break in the posterior lens capsule; *B*, elongated ciliary processes blending with fibrovascular sheath; *C*, retinal layer extending forward over the ciliary processes; *D*, shrunken cataractous lens; *E*, pupillary membrane adherent to the anterior capsule of the lens; × 12.

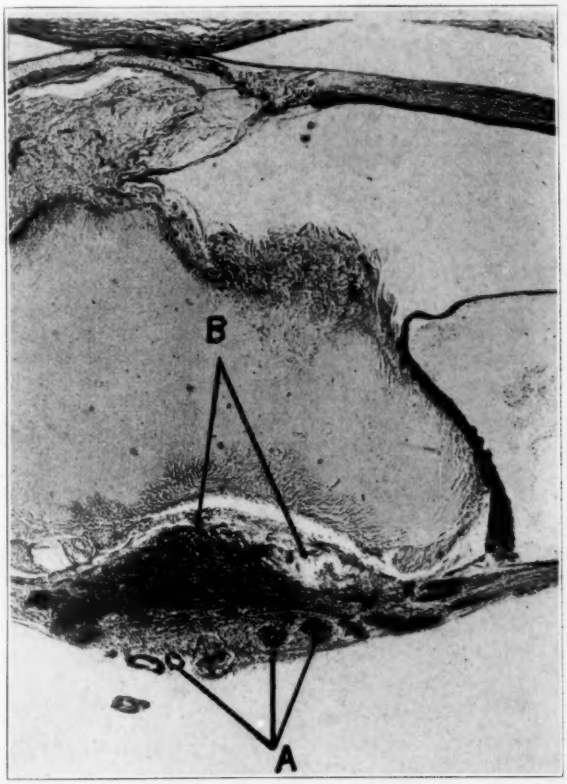

Fig. 5.—*A*, blood vessels in posterior fibrovascular sheath; *B*, break in the posterior capsule of the lens; × 30.

margin. The pupil was about 3 mm. in diameter, and did not react to light. It appeared to be occluded by a dense gray membrane, and no red reflex could be obtained through it. Atropine sulphate solution, 0.5 per cent, was ordered for instillation twice a day for two days, and the presence of the child was requested on the third day. On the next visit the observations were the same as on the previous examination. The pupil did not dilate with the use of atropine. The left eye appeared normal in all respects. Because of the inability to see into the eye, and on account of the extremely shallow anterior chamber, enucleation was decided on.

Pathologic Report.—The specimen was embedded in celloidin and stained with hematoxylin and eosin.

Sections taken through the greatest diameter measured 19 by 19 mm. Connective tissues, such as the sclera and ciliary muscle, showed large numbers of nuclei characteristic of an infant's eye. The cornea was normal, except for an

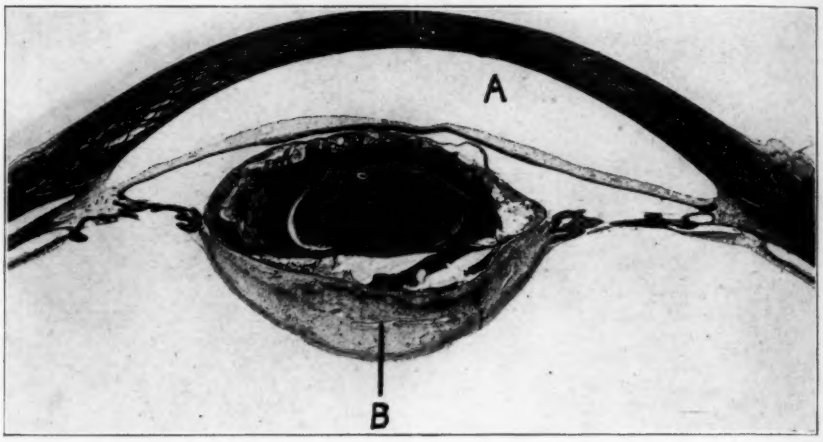

Fig. 6.—Lane's case showing a more usual type of persistent fibrovascular sheath: small eyeball; *A*, no infiltration of the iris or the anterior chamber; *B*, very thick posterior fibrovascular sheath, with elongated ciliary process attached to it. The slide is old and faded, and therefore the nuclei are not well seen; × 12.

increase of fixed corpuscles in the posterior layers of the central portion, adjacent to the anterior pole of the lens.

The anterior chamber was present only in the pupillary region and contained a few lymphocytes. The iris was thin and unusually dense, and showed a marked infiltration of lymphocytes. It was adherent posteriorly to the lens. There was a well formed pupillary membrane of fibrous tissue and blood vessels attached in its periphery to the shelf or small circle of the iris, pulling the stroma of the latter centrally in advance of the pigment layer; it was in contact with the cornea anteriorly and with the anterior capsule of the lens posteriorly. The lens was triangular, with the apex forward, and was moderately shrunken. Its capsule was wrinkled, and there was a well marked capsular cataract anteriorly and cortical cataract at the equator. Posteriorly the capsule of the lens was very thick and wrinkled, and there was a break at the posterior pole, through which fibroblasts had entered into the lens substance. There was a fairly well developed mass of

fibrovascular tissue outside of the lens at the posterior pole. The markedly atrophic ciliary processes were drawn over and adhered to this mass. The retina could be traced forward along the posterior surfaces of the ciliary processes; the posterior portion appeared normal. Parts of a persistent hyaloid artery, which contained blood, were seen in various sections, extending from the optic nerve to the mass behind the lens.

The diagnosis was persistent posterior fibrovascular sheath with a persistent hyaloid artery, persistent pupillary membrane and iritis.

In the photomicrographs there is the following evidence of inflammation: (1) cells in the anterior chamber; (2) fibrosis of the iris, with increased cellular infiltration; (3) capsular cataract and shrinking of the lens, and (4) retention of the pupillary membrane and posterior fibrovascular sheath with its attached hyaloid artery; this might be considered as an attempt of nature to clear the inflammation through these vascular systems.

CONCLUSION

The definite signs of inflammation found in this eye, associated with the persistence of fetal membranes, point to the probable cause of the congenital malformation in this case. It is reasonable to assume that Nature, in her endeavor to combat the inflammatory process, would leave behind a most ideal vascular system for this purpose. Could not arrested development of other eyes be due to a toxemia of some sort?

TREPHINING FOR BUPHTHALMOS

REPORT OF A CASE OBSERVED FOR SEVENTEEN YEARS *

CHARLES N. SPRATT, M.D.
MINNEAPOLIS

Buphthalmos, hydrophthalmos or congenital glaucoma is a rare condition. The reports of the New York Eye and Ear Infirmary for a ten year period show 49 cases with a diagnosis of buphthalmos among 230,000 patients. The records in my office include those of 38,000 cases, approximately two thirds of which were eye cases. There were three patients with buphthalmos, two male and one female. I performed a trephining operation on four eyes. One patient was under careful observation for seventeen years, and her case is one of the earliest ones reported in which this operation was performed.[1]

REPORT OF CASES

CASE 1.—Mildred R., aged 6, was seen by me on March 6, 1913. She was the only child of normal, healthy parents. The history obtained was as follows: At birth it was noticed that both eyes were prominent. When she was 4 months old, the left eye became red, and there was considerable lacrimation and much photophobia. This gradually became so severe that it was practically impossible to see the eyes, due to the intense spasm of the lids. Under an anesthetic both corneas were found to be transparent and 16 mm. in diameter; the pupils were dilated, and the anterior chambers were deep.

On April 28, 1913, the left eye was operated on, a trephine opening 2.5 mm. in diameter being made beneath a conjunctival flap. As soon as the instrument penetrated the sclera, a yellowish fluid escaped with considerable force from the top of the instrument. This was followed by a large hemorrhage into the anterior chamber. The eye later became quiet, and eventually went on to atrophy.

On May 26, 1913, a paracentesis of the anterior chamber was performed to relieve the tension of the right eye. Under a large conjunctival flap, a 2 mm. opening was made with a trephine at the sclerocorneal margin. In June, 1913, this patient was shown before the Section on Ophthalmology of the American Medical Association.[1] In August, 1913, she was able to count fingers at 7 feet (2.1 meters), there was no redness, lacrimation or photophobia, and she was able to read large print. There was moderate bulging over the trephine opening.

In March, 1914, the right eye seemed somewhat firmer, and there was some photophobia. Under anesthesia the eye showed a pressure of 45 mm. of mercury with the Schiötz tonometer. A conjunctival flap was made on the temporal side, and a 2 mm. trephine opening was made in the sclera about 1 mm. back from the sclerocorneal margin. In July, 1916, vision in the right eye was 6/200, and the patient was able to read Jaeger's test type number 2.

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* Submitted for publication, April 25, 1930.

1. Spratt, in discussion on Zentmayer, W.: Hydrophthalmos, J. A. M. A. **61**:1110 (Sept. 27) 1913.

She was seen at intervals afterward. On April 1, 1930, she was able to count fingers at 3 feet (0.9 meter) without a glass; with a minus 16.00 sphere vision was 10/200. The field was approximately 10 degrees in diameter, and there was a slight horizontal nystagmus. The tension was 36 mm. of mercury (McLean). The cornea was clear, except for two wavy horizontal tears in Descemet's membrane. The nerve was white with a grayish cast, and the cupping equaled 2 diopters. The patient had attended school, and could read the newspaper.

CASE 2.—In a boy, aged 4, the youngest of nine children, both eyes were very prominent; the corneas were white and projected beyond the lids. Both eyes were trephined, with no relief from symptoms. The right eye required removal later on account of pain. The patient was not seen again, but the relatives stated that

Fig. 1.—A patient with buphthalmos operated on by trephining seventeen years before.

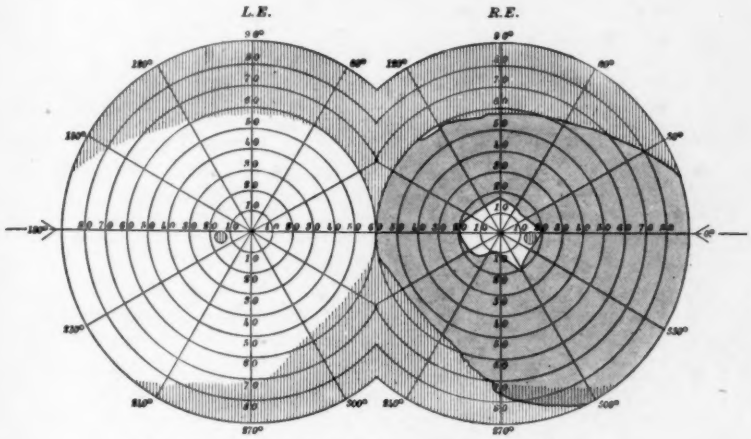

Fig. 2.—Visual field of the patient in figure 1.

the second eye was injured by striking against some object, and was removed elsewhere. The enucleated eye was 45 mm. in diameter anteroposteriorly, the cornea was 16 mm. in diameter, the iris was adherent to the angle in the sclera, and the canal of Schlemm was not present.

COMMENT

This subject was so thoroughly reviewed by Pyle [2] in 1899 and by Priestley Smith [3] in 1913 that it would be useless repetition to quote

2. Pyle, Walter: Philadelphia Month. M. J., 1899.

3. Smith, Priestley: Tr. 17th Internat. Cong. Med., London, 1913, sect. 9, part 1.

from them. The condition is usually so definite that the chance of mistaken diagnosis is slight. The treatment suggested has been repeated paracentesis, miotics, iridectomy and trephining. According to Collins,[4] the condition is a congenital defect in the angle of the anterior chamber, due to an abnormal persistence of the prenatal condition of the ligamentum pectinatum, and according to Reis, it is due to the absence of Schlemm's canal. The only logical treatment would seem to be the use of the small trephine, in order to allow the fluid to escape. If necessary, this may be done more than once. If any success is to be obtained in treating these patients, operation must be performed before the eye is badly stretched, and before there is optic atrophy due to pressure on the nerve.

Gros,[5] who collected forty-five cases, stated that the condition was recognized at or immediately after birth in 60 per cent, and that both eyes were involved in 63.7 per cent, and that boys are more frequently affected than girls, there being 61.2 per cent of the former.

Gifford[6] found that trephining in buphthalmos was not satisfactory. He reported two cases in which the tension quickly rose to the original point. He also reported one case in which iridotasis was performed, but this was followed by prolapse of the iris, and the high tension returned.

Blake[7] reviewed a total of 472 cases reported by American ophthalmologists, in which there were 156 operations. Various forms of treatment were summarized, the consensus being that the trephining is the most successful. The most complete study of the trephine operation in this condition was made by Bruno Fleisher[8] in 1918 from the University Eye Clinic at Tübingen.

In the Tübingen clinic the operation was done because of the favorable results which have resulted from the operation from the beginning, which results were confirmed by longer observation. The operation has been performed since 1912 in sixteen cases on twenty-three eyes. Among those are two older individuals and six eyes of children which had been operated only one year before and are not included in the consideration. In all cases the results were satisfactory, and the enlargement of the eye ceased to progress. In nearly all cases the tension became normal. In the eleven eyes which were followed for periods of three to six years, a complete healing of the glaucoma resulted. From our material we may conclude that the glaucoma of hydrophthalmos is reduced, and complete healing with good vision follows if the patients are treated before the end of the first year.

4. Collins, Treacher; and Reis, quoted by Parsons, J. H.: Pathology of the Eye, Hodder and Stoughton, 1904, vol. 3, p. 1120.

5. Gros: Thèse de Paris, March, 1897.

6. Gifford, H. A.: Ophth. Rev., August, 1916.

7. Blake, E. M.: Collective Study of Treatment of Congenital Hydrophthalmos, Arch. Ophth. **54**:1 (Jan.) 1925.

8. Fleisher, Bruno: Klin. Monatsbl. f. Augenh. **61**:152, 1918.

In a discussion of a paper read by Zeeman,[9] who performed chorio-dialysis fourteen times in five children and a trephine eleven times in seven children, the general opinion seemed to be that the trephine was the operation of choice, but it was dangerous in advanced cases, as a retinal detachment frequently followed, and several cases of late infection had occurred after the Elliott operation. All the authorities agree that if any satisfactory results are to be obtained, the operation must be performed early, just as in glaucoma in older persons—the less the tension and the earlier the case, the more favorable is the result.

Poulard and Lazart[10] observed eleven cases from 1913 to 1924. Twenty operations were done, the trephine being used in sixteen. In twelve of the seventeen eyes lowered tension followed. One of the patients was under observation for twelve years, and had one-fourth normal vision in each eye. Six had sight permitting of normal activities, and in three cases there was no improvement.

9. Zeeman, W. P. C.: Netherlands Ophth. Soc., Am. J. Ophth. **2**:144, 1919.
10. Poulard and Lazart: Ann. d'ocul. **162**:496, 1924.

CAR-SICKNESS *

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Certain persons experience discomfort in traveling by automobile or railroad, though this number is relatively few as compared to those affected by riding in a ship or aeroplane. The universal experience in all forms of travel is that the smoother the trip, the greater the degree of comfort, so that it is now generally admitted that labyrinthine stimulation is an important factor in all these cases. Children are less subject to seasickness than adults, but in car-sickness the reverse is true, probably because the adult has already acquired a tolerance to this type of locomotion. The tendency to car-sickness often runs in families, suggesting a hereditary predisposition. Those susceptible usually avoid riding backward and favor the front seat of the automobile, where there is less jarring, and where the view is less constricted.

When the land traveler gazes at the scenery, an ocular phenomenon results which is not characteristic of transport by sea or air. The eyes slowly follow the objects in the landscape, which are apparently moving backward, and as the object of gaze passes out of the field of vision, by a rapid saccadic movement the eyes return to their normal position, fix some other object and repeat the movement. Thus a biphasic nystagmus results, with its fast component in the direction of the moving train and its slow component in the direction of the apparently moving objects.

In all probability it is this "railroad nystagmus" that has led various physicians to believe in an ocular basis for car-sickness. The not uncommonly used term "panoramic headache" illustrates this point of view. Discussing ocular orientation, Hazen [1] stated the belief that car-sickness and seasickness belong to a disorder of muscle function. In the "American Encyclopedia of Ophthalmology" [2] the view is expressed that "in a percentage of cases the discomfort is due wholly or partially to ametropia or oculomotor defects. Treatment of the eye anomaly not uncommonly cures or relieves the car-sickness." In seventy-five patients with car-sickness, Ayres [3] found thirty with inverse hypermetropic astigmatism. All of the patients were benefited by the wearing of correct lenses.

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* Submitted for publication, May 19, 1930.

* From the Departments of Ophthalmology and Physiology, Northwestern University.

1. Hazen, E. H.: Ocular Orientation, Arch. Ophth. **49**:434 (July) 1920.
2. "Car-sickness," American Encyclopedia of Ophthalmology **2**:1429, 1913.
3. Ayres, W. McL., cited in footnote 2.

In car-sickness, as in seasickness, the feeling of nausea is the dominant sensation. Associated with this is pallor and dejection, sweating, salivation and pilomotor changes (so-called goose flesh). These phenomena accompany nausea howsoever produced. They are presumably derived from a reflex spread to the sympathetic system.

The primary changes in nausea are in the digestive tract. Even before nausea comes to consciousness, Colley [4] has observed definite motility disturbances in the stomach. The pylorus stays in constant occlusion, and the fundus is in long-continued atony with the cardia relaxed. As the nausea advances, gastric retroperistalsis and vomiting follow. On the basis of fluoroscopic studies, Keeton [5] noted that "a sudden cessation of the antral waves with a relaxation of the fundus almost always indicates that the patient is nauseated. This relaxation is a necessary condition for antiperistalsis."

The studies of Alvarez,[6] Keeton,[7] Brunemeier and Carlson [8] and Ivy and Vloedman [9] have demonstrated that this gastric inhibition is accompanied and in fact preceded by duodenal antiperistalsis. Alvarez [10] stated the belief that "the nausea and vomiting caused by disgusting mental impressions, by rolling movements as at sea, and by cerebral disease might conceivably be due to the reversal of the gradient in the gastro-intestinal tract brought about by an unequal or dissimilar action of the vagus on different parts of the stomach or bowel."

By utilizing this knowledge of the physiology of nausea, one is able experimentally to evaluate the factors that have been assumed to play a rôle in the syndrome of car-sickness. For the induction of optic nystagmus, a drum in which the concavity has been marked with vertical stripes, alternately black and white, is revolved before the eyes. In order that the gastric movements may be followed, a stomach balloon is swallowed, connected with a water manometer, and a tracing is made on the smoked paper of a revolving kymograph. The balloon is emptied of air before it is swallowed and is inflated to a pressure of

4. Colley, cited by Bruns, O., and Hornicke: Die Behandlung der See,-Luft,- und Eisenbahnkrankheit, München. med. Wchnschr. **75**:167, 1928.

5. Keeton, R. W., and Nelson, E. S.: Treatment of Nausea and Certain Related Circulatory Sensations, J. A. M. A. **90**:683 (March 3) 1928.

6. Alvarez, W. C.: Reverse Peristalsis in the Bowel, J. A. M. A. **85**:1051 (Oct. 3) 1925.

7. Keeton, R. W.: Nausea and Related Sensations Elicited by Duodenal Stimulation, Arch. Int. Med. **35**:687 (June) 1925.

8. Brunemeier, E. H., and Carlson, A. J.: Reflexes from the Intestinal Mucosa to the Stomach, Am. J. Physiol. **36**:191, 1915.

9. Ivy, A. C., and Vloedman, D. A.: Small Intestine in Hunger, Am. J. Physiol. **72**:99, 1925.

10. Alvarez, W. C.: Syndrome of Mild Reverse Peristalsis, J. A. M. A. **69**:2018 (Dec. 15) 1917.

about 5 cm. of water after it has reached the stomach. In an investigation of oculogastric reflexes,[11] I used the same method of studying gastric motility, and in this article are illustrations of the apparatus.

Regularly on the induction of optic nystagmus, there is an increase in the respiratory excursions, a definite increase in gastric tone and a mild acceleration of gastric motility. Though a sense of movement is induced by the revolving drum, the sensation is not unpleasant, and is not accompanied by gastric disturbance. Revolving the drum to and fro

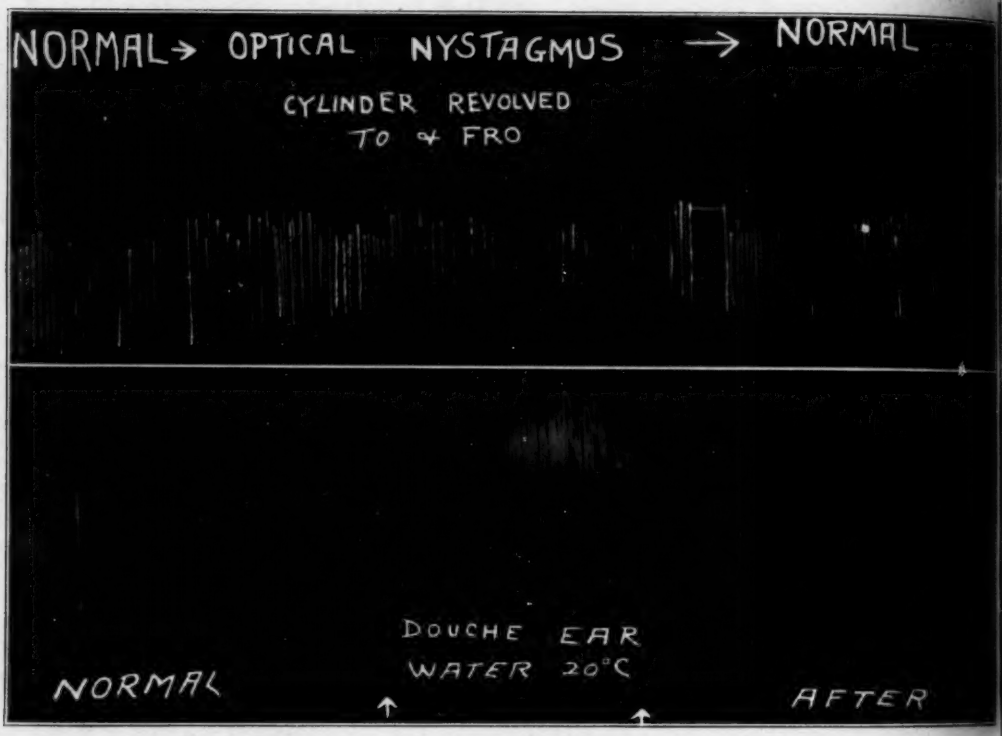

Fig. 1.—Kymographic tracings of the movements of the empty stomach. With the induction of optic nystagmus there is a slight increase in gastric tone and in gastric motility as shown in the upper curve. After stimulation of the labyrinth with cold water there is a marked decrease in gastric tone and an inhibition of gastric motility as shown in the lower curve. The initial contraction is not of labyrinthine origin but is due to stimulation of the adjacent skin nerves.

produces a greater change in gastric activity than revolving the drum in one direction only. The production by prisms of ocular muscle imbalance did not appreciably change the type of reaction.

11. Lebensohn, J. E.: Oculo-Visceral Reflexes, Am. J. Ophth. **12**:562, 1929.

Douching an ear with cold water effected an immediate and remarkable rise in gastric tone. If the douching is stopped just after vertigo is established, there is a prompt fall of gastric tone to below its original level and a cessation of gastric motility until some minutes after the sensation of vertigo has passed (fig. 1). The same phenomenon is induced by irrigating the ear with hot water, but douching the ear with lukewarm water occasions practically no change in gastric motility.

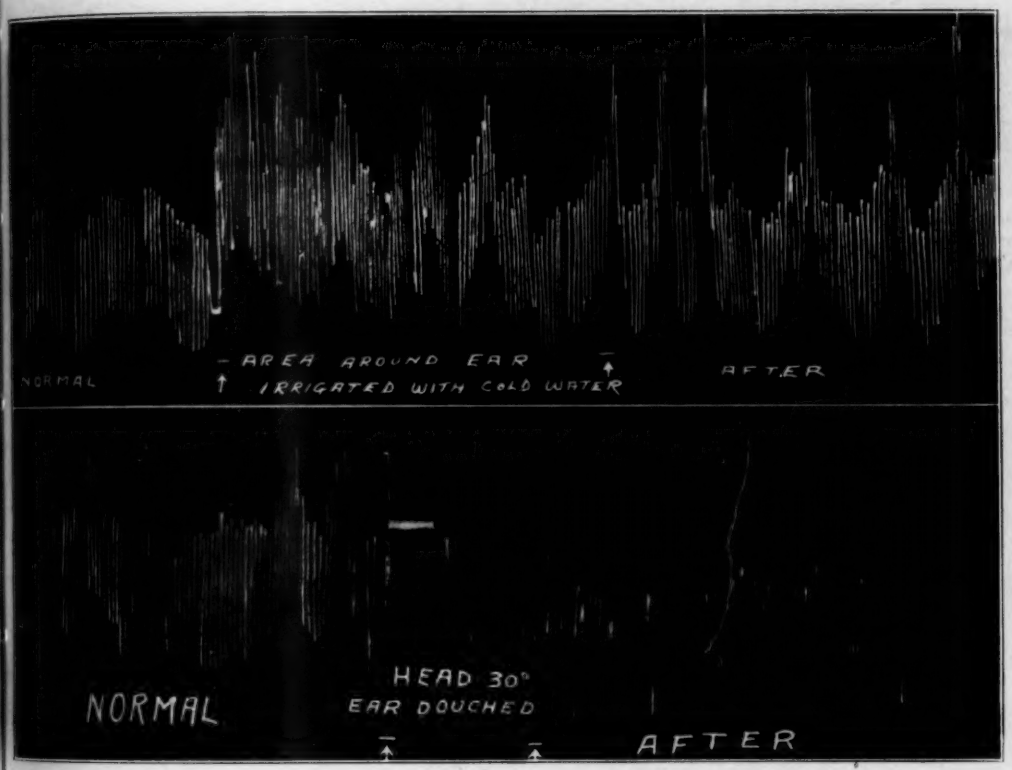

Fig. 2.—Kymographic tracings of the movements of the empty stomach. Irrigating the auricle and face with cold water causes a prompt and sustained increase in gastric contractions as shown in the upper curve. Hunger contractions, developed during the irrigation, continue with unabated vigor afterward. After the labyrinth is stimulated with cold water, hunger contractions are stopped, and a loss of gastric tone accompanies the ensuing nausea as shown in the lower curve.

The initial gastric contraction is not due to the labyrinth, but is a response to the stimulation of the adjacent skin nerves. Irrigating the auricle and face with cold water causes a prompt and sustained increase in gastric contractions. The effect is purely tonic, and may go on to hunger contractions during the irrigation, which in that case continue

with unabated vigor afterward. If the area around the ear is irrigated with cold water, and then, without pause, the douche is directed toward the labyrinth, no further increase in gastric activity occurs. Stimulation of other peripheral nerves, as accomplished by irrigating the chest, foot and arm with cold water, is only slightly tonic, but has a tonic after-effect, the stomach at times going into a hunger period shortly after the stimulation.

Irrigating the aural canal, however, with the excitation of vertigo and nystagmus has regularly a depressive after-effect. Hunger contractions which may have continued through the initial irrigation stop with the cessation of douching if not before, and a loss of gastric tone occurs, depending on the degree of nausea induced (fig. 2). With the production of nausea, there is an accompanying pallor of the face, a general cold sweat and a fall in systemic blood pressure.

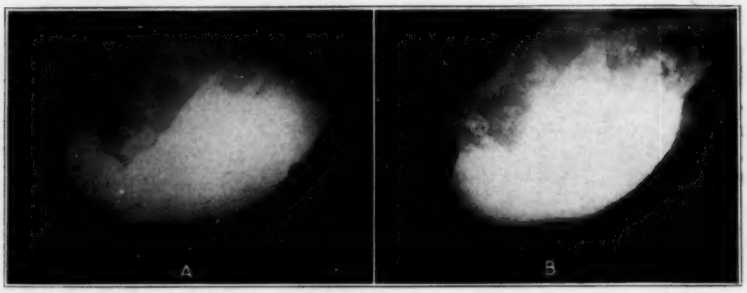

Fig. 3.—*A*, the normal stomach after a barium sulphate meal; *B*, after incipient nausea is induced by douching ear with cold water. The pylorus is closed, and the fundus is relaxed and atonic.

The effects of galvanic stimulation are similar. Unless the electrodes are directly in the aural canal, vertigo and nystagmus are seldom produced. With binaural stimulation of the labyrinth, marked vertigo and nystagmus are easily produced with a 5 to 6 milliampere current. The first few experiments in a day's series would produce, after stimulation, nausea and a fall in gastric tone. Succeeding experiments would occasion no gastric distress and no loss in gastric tone, but an inhibition of rhythmic motility if previously present.

From these experiments, one can definitely conclude that car-sickness is due to labyrinthine stimulation rather than to optic nystagmus. Optic nystagmus is easily tolerated and is not accompanied by depressive gastric phenomena. The impulses from the labyrinth, however, are depressive. Gastric hunger contractions are inhibited, and when nausea is induced, a marked decrease of gastric tonus regularly results. Roentgenograms of the stomach taken after a barium sulphate meal show that when nausea is induced by labyrinthine stimulation, the stomach

becomes atonic and relaxed (fig. 3). This is confirmatory of the observations previously noted in the gastric tracings.

That the depressive effects of car-sickness are not due to optic nystagmus is also indicated by certain *a priori* considerations. Optic nystagmus is entirely dependent on attention and ceases immediately when the attention is withdrawn. In the production of optic nystagmus no great demands are made on the visual function. It is only necessary that some vision be present. Optic nystagmus occurs with diminished visual acuity, central scotoma and large field defects. In the presence of paralysis of the eye muscles, the eye movements continue in one or both eyes to the extent still permitted. It is only in certain cases of cerebral lesions that optic nystagmus to one or both sides is abolished.

Though car-sickness is based on labyrinthine irritation, it is nevertheless true, I believe, that errors of refraction and of muscle balance predispose a person to this malady. In my work on oculogastric reflexes,[11] I demonstrated that asthenopia and muscle imbalance acted as gastric depressants. Hence persons so affected have probably a lowered threshold for nausea, and a digestive tract especially susceptible to further depressing influences.

With the advent of smoother roads and easier riding cars and automobiles, car-sickness is becoming less common. Susceptible persons will be less affected if they maintain a proper gastro-intestinal tone. Errors of refraction and muscle imbalance should be corrected. It is best not to go hungry when traveling, as the empty stomach is particularly sensitive to depressing influences. In severe cases, it may be necessary to allay the psychic tension with sedatives, while to counteract the pylorospasm which precedes the retroperistalsis, the use of atropine is indicated. The value of sodium nitrite in seasickness[12] has not been confirmed by British investigators.[13]

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12. Pearcy, J. F., and Hayden, D. B.: Sodium Nitrite Therapy in Seasickness, J. A. M. A. **90**:1193 (April 14) 1928.

13. Eldes, A. V.: Treatment of Seasickness by Sodium Nitrite, M. Press **126**:305, 1928.

THREE CASES OF KERATOCONUS

FINAL REPORT *

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AND
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The authors two years ago [1] published a preliminary report of a comprehensive study of three cases of keratoconus in which, based on roentgenologic studies of the skulls, it was suggested that a careful examination of the calcium metabolism in such cases might lead to a clue concerning their etiology. Briefly, exhaustive clinical examination of the patients in the three original cases, careful search of the family histories and minute inquiry into the personal histories did not reveal any abnormality that might serve as a point of departure on which to build a logical theory as to etiology except that in all three cases the x-ray pictures of the skulls showed in more or less numerous areas apparent lack of calcification. The basal metabolism was also found to be low. With this in one case was found great softness of the teeth. The results of the historical and physical examinations other than as stated were commonplace, merely such haphazard conditions as would be expected under any circumstances to be found in persons of the second and third decade. But this fact in itself seemed to point significantly to the possibility that in our own as well as in previous inquiries into the subject by others, examinations, both clinical and historical, were not sufficiently comprehensive to include the physical sources. For certainly such there must be.

Aside from the observations of previous investigators, our experience with our three cases revealed the apparent lack of calcification of the skulls, of which we could find no previous report. This seemed to be a lead sufficiently promising to warrant further study. In consequence, we undertook the further investigation of the calcium metabolism in our three original cases and, in addition, ten others. Of the ten additional cases, two were incipient, six were well advanced and two were apparently actively progressing. In none of the new cases was there found any significant variation, in general, from the clinical conditions in the three original cases.

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* Submitted for publication, May 27, 1930.

* From the Research Laboratory of the Beth Israel Hospital, New York; Ervin Torok, M.D., Chief of Service; L. D. Redway, M.D., Director of Research.

1. Torok, Ervin; and Redway, L. D.: Arch. Ophth. **57**:19, 1928.

Respecting the determinations of the calcium metabolism, these concerned microchemical reactions, in the study of which we followed the most recent modifications of the technic in use at the New Jersey State Hospital for the Insane at Trenton, and according to our results, while variations in reactions were found among the individual patients, those for the group, as a whole, irrespective of age, of sex and of the stage of the disease, were found to be definitely within the limits of normal fluctuations. Two series of determinations were made: The first, while the patients were without treatment of any kind, showed low basal metabolic rates; the second, while they were being fed desiccated thyroid gland, showed an increase in the metabolic rates to normal or above. In neither series was there noticed any variation from normal limits in the calcium metabolism.

Of the ten new cases, three showed what appeared to be areas of deficient calcification in the skull; the other seven did not. Nor were there found any abnormalities of the long bones or changes in the epiphyses of these. While it is true that some improvement in vision was noticed in nearly all cases during the time that thyroid extract was being administered, this is thought to have been due rather to the resultant improvement in metabolic rate than to any other cause, since no improvement in the already developed conus was noted in any case.

As a result of further experimental work, the authors conclude that in all probability the presence of areas of lessened calcification in the skull in their first three cases was the results of chance and was in no way related to the disease; that so far as our present admittedly imperfect technic of studying the calcium metabolism shows, there is no relation between it and keratoconus, and that the administration of thyroid gland derivatives has no permanent curative value.

While nothing of positive worth has resulted from the exhaustive study of these cases of keratoconus, at least certain possibilities have been run down to their experimental limit within the scope and accuracy of the available technical means for studying them. And if the question of what causes keratoconus has not been answered, our work may be said at least to have shown, or to have called attention to, some factors that in all probability do not—a negative result that in the general process of elimination leading to a final successful conclusion may have some value.

THE PERMEABILITY OF THE LENS CAPSULE TO WATER, DEXTROSE AND OTHER SUGARS *

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In a previous paper [1] quantitative studies on the permeability of the lens capsule to various colloid and crystalloid analine dyes were reported, together with qualitative studies in regard to the permeability for various other organic and inorganic substances. In view of the importance of water and dextrose in the normal metabolism of all tissues and in view of the experimentally demonstrated dextrose consumption of the lens [2] it seemed desirable to obtain, if possible, experimental data of a quantitative nature in regard to the permeability of the lens capsule for water and dextrose. The method that was devised for these experiments was very simple. The apparatus is shown in figure 1. The experimental procedure was as follows:

Capsules removed from the lenses of freshly enucleated eyes were cleansed by prolonged shaking in frequent changes of physiologic solution of sodium chloride, as described in the previous paper,[1] in order to free them from all traces of adherent lens protein. One such capsule was then tied onto the tube at *C* (fig. 1). The interior of the tube above the capsule was then filled with physiologic solution of sodium chloride, and the capsule immersed in a similar solution. The experiments were all performed at room temperature from 20 to 22 C., the uncontrollable daily variations having been demonstrated to be too small to affect the readings. The apparatus was first allowed to rest in this condition for one-half hour in order to observe any leaks. The interior of the tube was then emptied of salt solution and, after several washings, was refilled with physiologic solution of sodium chloride containing measured amounts of dextrose or other sugars, and the capsule again immersed in 10 cc. of physiologic solution of sodium chloride. After varying intervals, the amount of dextrose that had diffused through the membrane into the lower receptacle was measured by the usual chemical procedure, and the movement of the meniscus in the capillary arm of the apparatus was also recorded. Since the diffusion pressure forcing the sugar downward through the membrane must be exactly equal to the osmotic pressure forcing the water upward, whatever the actual concentration of sugar

* Submitted for publication, May 13, 1930.

* From the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital.

* I am indebted to Mr. Paul Spear for technical aid in the performance of these experiments.

1. Friedenwald, Jonas S.: Permeability of the Lens Capsule: With Special Reference to the Etiology of Senile Cataract, Arch. Ophth. **3**:182 (Feb.) 1930.

2. Kronfeld, P.: Ber. d. deutsch. ophth. Gesellsch. **46**:230, 1927.

on either side, by this device, we were able to obtain a valid measurement of the relative permeability of the membrane to these two substances free from any experimental or systematic errors in our measurements of the concentration of sugar on the two surfaces of the membrane.

Such direct measurements of the relative permeability of the membrane for water and sugars were used for the main elements of the following study, because it was soon found that the absolute permeability of the membrane for any of the substances tested could be obtained only by more complicated and indirect calculation. It was found that the diffusion of dextrose across the membrane was so rapid that a film of dextrose solution of concentration considerably higher than in the bulk of the lower receptacle was formed on the lower surface of the membrane. Similarly, the diffusion of water across the

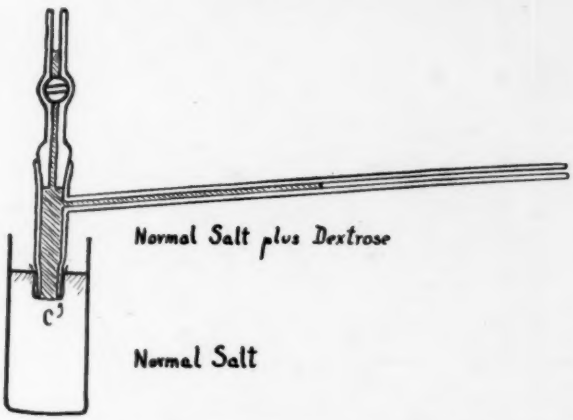

Fig. 1.—Apparatus for measuring rates of diffusion of water and sugars across the membrane.

membrane was so rapid that a film of relatively reduced concentration was formed on the upper surface of the membrane. As a result the concentration difference operating across the membrane is reduced to a small fraction of the concentration difference between the bulk of solution in the upper and the lower part of the apparatus. In the experiments as outlined no data are obtained as to the actual difference in concentration across the membrane; therefore, the actual osmotic and diffusion pressure operating across the membrane could not be calculated, and, hence, the absolute permeability of the membrane in terms of the amounts of substances diffusing through the membrane across a unit of area in a unit of time and under a unit of pressure was unknown. Indirectly, however, the operating osmotic pressure could be estimated by comparing the rate of flow of water through the

membrane under the influence of the unknown osmotic pressure, with similar rates of flow produced by hydrostatic pressure.

The diffusion rate of water under the influence of hydrostatic pressure, however, cannot be compared unreservedly to the diffusion rate of water under the influence of osmotic pressure, for the hydrostatic pressure distends the membrane and thus alters the area of diffusion, and also, presumably, the pore size of the membrane. A preliminary series of experiments, therefore, was performed to discover

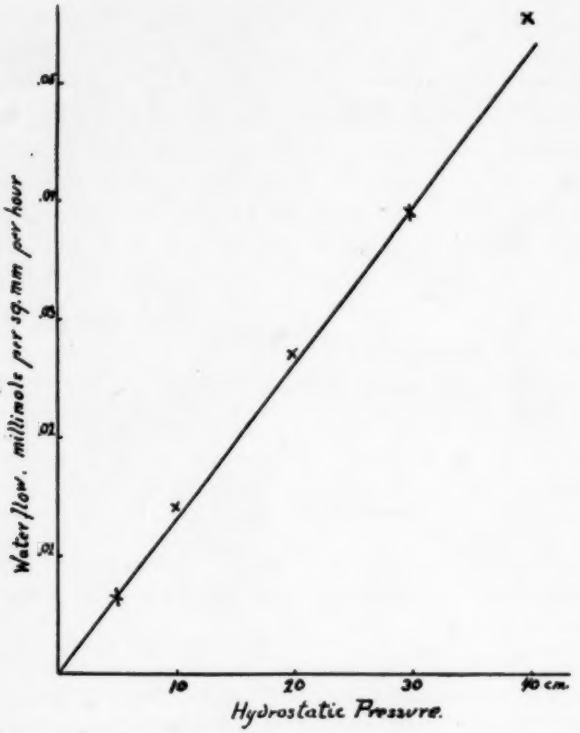

Fig. 2.—Relation of hydrostatic pressure to water flow across the membrane.

the relations between the rate of flow and hydrostatic pressure. For this purpose the apparatus described was slightly modified so as to enclose the space above the water level in the lower receptacle, and this air trap was then connected with a pressure bottle and a water manometer. The rate of movement of the meniscus in the capillary arm under the influence of various externally applied pressures was then measured. It was found that up to 40 cm. of hydrostatic pressure the relation between flow and pressure was substantially linear, as is shown in figure 2. This indicates that errors resulting from the

stretching of the membrane do not reach significant magnitudes at lower levels of hydrostatic pressure. In the data to be given, therefore, the effective osmotic pressure was always calculated by comparing the flow of water under the unknown osmotic pressure with that under a hydrostatic pressure of not more than 20 cm.

In a diffusion experiment such as that outlined the concentration of sugar on both sides of the membrane must eventually approach equality and the rate of diffusion slow down to zero. It was found by experiment, however, that such a slowing of the diffusion rate became demonstrable within the errors of measurement of the procedure only after an hour of diffusion. In the data to be reported, therefore, the experiments were always terminated after one-half hour of diffusion.

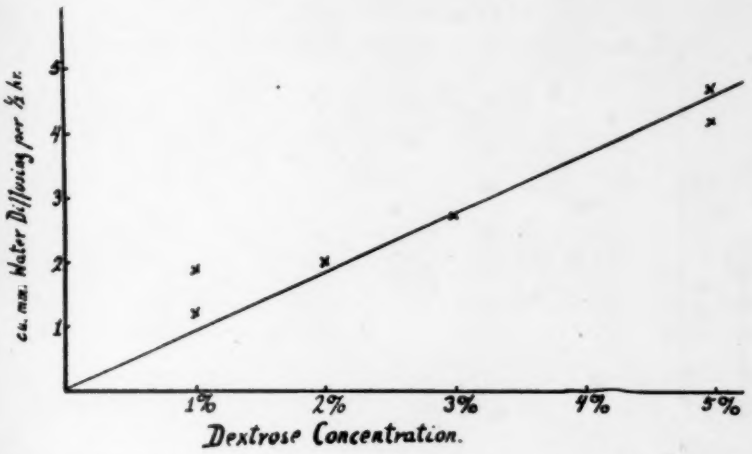

Fig. 3.—Relation of dextrose concentration to water flow across the membrane.

In almost every case duplicate and sometimes triplicate experiments were performed on the same capsule. Measurements were made in terms of cubic millimeters of water and of milligrams of sugar diffusing through the membrane in half an hour. In comparing the diffusion rates of sugars with that of water, these values are transformed into millimols. In those experiments in which the flow through the capsule under hydrostatic pressure was also measured the absolute diffusion rates are also given in terms of millimols of water or sugar diffusing through 1 sq. mm. of membrane in one hour under the influence of an effective osmotic or diffusion pressure of a molar solution.

One additional check was required before proceeding with our experiments. It was thought possible that the lens capsules in our experiments, being in contact with solutions of far higher concentration

(5 per cent dextrose) than those to which they are exposed under physiologic conditions, might be physically altered by this contact. A series of measurements was made, therefore, varying concentrations of dextrose being used. Within the limits of error of the experiment the rates of diffusion of water and dextrose were found to be directly proportional to the concentration of dextrose used, as is shown in figure 3.

I. PERMEABILITY OF THE LENS CAPSULE TO WATER, DEXTROSE, SUCROSE AND RAFFINOSE

In table 1 the results of a typical experiment performed as outlined on capsules of cows' and calves' lenses are given. The data presented in this table illustrate very well the decrease in the permeabilty of the

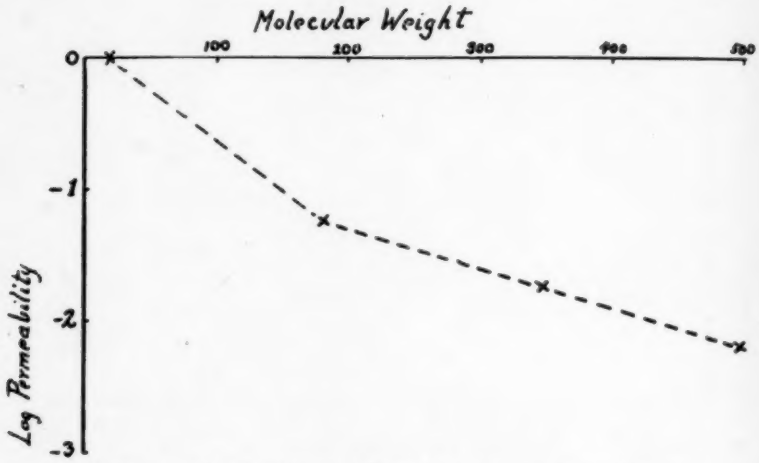

Fig. 4.—Variation in permeability with molecular weight.

lens capsule with age, which we have already found in our previous studies with aniline dyes. This aspect of the investigation will be dealt with more extensively in section V. There is also a marked decrease in permeability with increasing molecular size. In figure 4 the relation between rate of diffusion and molecular weight is shown graphically, the numbers representing the averages of all experiments of the type shown in table 1.

Perhaps the most unexpected observation illustrated in table 1 is the fact that the effective osmotic pressure across a given membrane produced by 5 per cent solutions of dextrose, sucrose and raffinose are all very nearly equal, although the actual osmotic pressure of the sucrose and raffinose solutions are, respectively, approximately one-half and one-third that of the dextrose solution. This apparent anomaly may be explained, however, by a consideration of the percentage of

effective osmotic pressure shown in the table. The permeability of the capsule to dextrose is so great that less than 0.2 per cent of the expected pressure is actually operative across the membrane. In the cases of sucrose and raffinose the permeability is considerably less. As a result these sugars accumulate in the fluid layer immediately adjacent to the under surface of the lens capsule in relatively smaller concentration than does dextrose, and the concentration difference across the mem-

TABLE 1.—*Results of a Typical Experiment on Capsules of Cows' and Calves' Lenses*

	C.Mm. Water Flow ½ Hour; Hydrostatic Pressure 20 Cm. Water	5% Dextrose		5% Sucrose		5% Raffinose	
		C.Mm. Water Flow ½ Hour	Mg. Dextrose ½ Hour	C.Mm. Water Flow ½ Hour	Mg. Sucrose ½ Hour	C.Mm. Water Flow ½ Hour	Mg. Raffinose ½ Hour
Cow's capsule	0.6	3.7	2.86	3.9	1.88	5.3	1.21
		4.7	2.58	4.8	1.61	5.7	1.13
		4.4	3.09	4.7	....	4.7	1.27
Average	0.6	4.3	2.84	4.5	1.75	5.2	1.20
Relative molar permeabilities	...	1.0	0.0660	1.0	0.0205	1.0	0.00690
Calf's capsule	1.7	5.3	2.90	5.5	2.12	5.8	1.15
		5.2	2.53	6.3	2.02	6.8	1.11
		5.9	....	5.9	1.51	5.9	1.20
Average	1.7	5.5	2.72	5.9	1.88	6.2	1.15
Relative molar permeabilities	...	1.0	0.0495	1.0	0.0168	1.0	0.00562
				Water	Dextrose	Sucrose	Raffinose
Osmotic pressure (atmospheres) 5% solution				....	6.64	3.65	2.02
Cow's capsule							
Effective osmotic pressure (atmospheres)				....	0.0145	0.0152	0.0175
Percentage effective osmotic pressure				....	0.22	0.42	0.87
Estimated permeability of capsule: millimols per sq. mm. per gram molecule osmotic pressure, per hour				41.8	2.76	0.857	0.282
Calf's capsule							
Effective osmotic pressure (atmospheres)				....	0.00655	0.00703	0.00722
Percentage effective osmotic pressure				....	0.10	0.19	0.36
Estimated permeability of capsule: millimols per sq. mm. per gram molecule osmotic pressure, per hour				118.0	5.78	1.99	0.666
Permeability cow's capsule				35.4%	47.1%	54.2%	42.4%
Permeability calf's capsule							

brane is maintained at correspondingly higher levels. The fact that the resultant effective osmotic pressure is of approximately the same magnitude in all three cases is therefore merely an accident due to the relative speeds of the three kinds of sugar molecules through the membrane and in water. It has already been shown in figure 3 that when the concentration of a single sugar, dextrose, is varied the flow of water is directly proportional to the concentration. The percentage of effective osmotic pressure is, therefore, a constant characteristic of each sugar and independent of the total concentration of sugar solutions used.

II. EFFECT OF p_H ON THE PERMEABILITY OF THE LENS CAPSULE TO WATER AND DEXTROSE

In testing the effect of p_H on the permeability of the lens capsule the same experimental procedure was used, with the exception that sufficient amounts of buffer salts were added to the solutions on each side of the membrane to bring the concentration of the total buffer salts to hundredth-normal. Since the only other substances in these solutions were sodium chloride and dextrose, it was felt that this concentration of buffer was sufficient to control the p_H of the solution, and this was verified occasionally by colorimetric methods. The results of these experiments, shown in table 2 and figure 5, make it clear that changes in p_H do not significantly affect the permeability of the lens capsule for water and dextrose. This must not be taken to mean that the lens

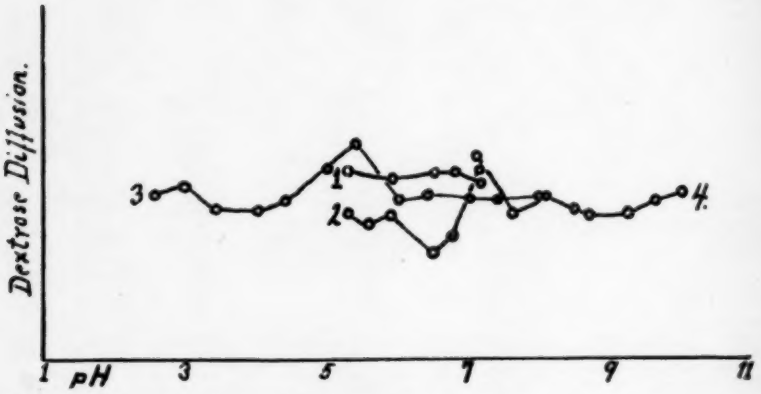

Fig. 5.—Effect of changes in p_H on the permeability of the lens capsule; graphic representation of the data shown in table 2.

capsule has no iso-electric point, or that the permeability of the capsule remains unchanged at the iso-electric point. The data merely show that, within the margin error of the method used, no changes in permeability attributable to an iso-electric point could be discovered.

III. EFFECT OF PROTEINS ON THE PERMEABILITY OF THE LENS CAPSULE TO WATER AND DEXTROSE

In the earlier experiments reported elsewhere [1] it was found that the presence of proteins, even in small quantities, in the solutions with which the lens capsule was placed in contact markedly reduced the permeability of the capsule for colloid aniline dyes. It was of interest to discover whether the same effect could be demonstrated in relation to small molecules such as those of water and dextrose. The rates of diffusion of dextrose and water were therefore measured on a given capsule for

several experimental runs. Fresh solutions were then introduced on either side of the membrane containing the same amounts of dextrose and sodium chloride and, in addition, 0.1 per cent of crystalline egg albumin. The results shown in table 3 indicate a marked reduction in permeability to dextrose and a slight reduction in permeability to water.

TABLE 2.—*Effect of Changes in p_H on the Permeability of the Lens Capsule* *

Capsule:	I		II		III		IV	
Buffer:	Na_2HPO_4 + KH_2PO_4		Na_2HPO_4 + KH_2PO_4		Citric acid + NaH_2PO_4		Borax + Boric acid p_H 7.1-8.7 Borax + Na_2CO_3 p_H 9.2-10.0	
	Water	Dextrose	Water	Dextrose	Water	Dextrose	Water	Dextrose
p_H	C.Mm.	Mg.	C.Mm.	Mg.	C.Mm.	Mg.	C.Mm.	Mg.
10.0	....	....	...	....	...	....	4.7	2.34
9.6	....	....	...	....	...	....	5.1	2.26
9.2	....	....	...	....	...	....	4.6	1.98
8.7	....	....	...	....	...	....	5.1	1.99
8.5	....	....	...	....	...	....	4.9	2.09
8.1	....	....	...	....	...	....	5.1	2.30
8.0	....	....	...	....	3.4	2.29	...	....
7.6	....	....	...	....	...	....	5.3	2.05
7.4	....	....	...	....	3.1	2.26	...	....
7.2	5.15	2.52	3.8	2.61	...	....	...	....
7.1	....	....	...	....	...	....	5.1	2.86
7.0	....	....	...	....	3.3	2.25	...	....
6.8	6.22	2.63	4.0	1.74	...	....	...	....
6.5	5.1	2.61	4.2	1.66	...	....	...	....
6.4	....	....	...	....	3.9	2.31	...	....
6.0	....	....	...	....	3.7	2.24	...	....
5.9	4.7	2.56	3.9	2.04	...	....	...	....
5.6	....	....	4.1	1.91	...	....	...	....
5.4	....	....	...	....	4.7	3.17	...	....
5.3	5.3	2.63	4.2	2.04	...	....	...	....
5.0	....	....	...	....	2.9	2.70	...	....
4.4	....	....	...	....	2.7	2.18	...	....
4.0	....	....	...	....	3.8	2.12	...	....
3.4	....	....	...	....	3.5	2.16	...	....
3.0	....	....	...	....	3.0	2.47	...	....
2.6	....	....	...	....	2.9	2.37	...	....

* Pig's lens capsules were used, the upper chamber being filled with 5 per cent dextrose. The determinations were made after one-half hour of diffusion.

TABLE 3.—*Effect of Protein on the Permeability of the Lens Capsule* *

		Water, C.Mm.	Dextrose, Mg.
Without protein	1	3.2	3.10
	2	3.7	2.47
	3	4.3	2.68
With 0.1 per cent protein	4	3.4	0.35
	5	2.6	0.32
	6	2.8	0.40
	7	...	0.37

* Pig's lens capsule was used, the upper chamber being filled with 5 per cent dextrose. Determinations were made after each one-half hour of diffusion.

IV. EFFECT OF CA^{++} AND CN^{-} ON THE PERMEABILITY OF THE LENS CAPSULE TO WATER AND DEXTROSE

Experiments similar to those performed with protein were performed to determine the effect of Ca^{++} on the permeability of the membrane. After repeated control runs, fresh solutions to which 0.1 per cent calcium chloride had been added were brought in contact with the membrane.

The results shown in table 4 indicate a slight reduction in the permeability to dextrose but no appreciable effect on the permeability to water.

A similar small effect in the same direction was found on the addition of 0.1 per cent sodium cyanide to the solution as shown in table 5.

V. EFFECT OF AGE ON THE PERMEABILITY OF THE LENS CAPSULE FOR WATER AND DEXTROSE

For these experiments the rabbit was chosen as the animal best suited for the purpose on account of the large size of its lens and the short length of its life. Measurements were made in triplicate on each

TABLE 4.—*Effect of Calcium Chloride on the Permeability of the Lens Capsule* *

		Water, C.Mm.	Dextrose, Mg.
Without calcium chloride	1	5.6	3.39
	2	6.4	3.63
With 0.1 per cent calcium chloride	3	4.4	2.98
	4	4.9	2.98
	5	6.1	3.17

* A pig's lens capsule was used, the upper chamber being filled with 5 per cent dextrose. Determinations were made after each one-half hour of diffusion.

TABLE 5.—*Effect of Sodium Cyanide on the Permeability of the Lens Capsule*

		Water, C.Mm.	Dextrose, Mg.
Without sodium cyanide	1	5.3	3.39
	2	5.4	3.63
	3	...	3.63
With 0.1 per cent sodium cyanide	4	5.8	2.98
	5	6.2	2.98
	6	...	3.17

* A pig's lens capsule was used, the upper chamber being filled with 5 per cent dextrose. Determinations were made after each one-half hour of diffusion.

capsule to determine the rates of diffusion of water, dextrose, sucrose and raffinose. The flow of water through the membrane under hydrostatic pressure was also measured, enabling one to estimate roughly the absolute permeability of the membranes to these substances as well as the relative permeabilities. Table 6 presents the experimental data, each diffusing period being one-half hour in duration. Table 7 shows the average of these determinations in each age group in terms of relative molar amounts of diffusing substance, the data for water diffusion in the whole table having been lumped together in a single average figure in order to give a standard of comparison. Finally, with the aid of the figures on hydrostatic flow an approximate estimate of the permeability of the rabbit's lens capsule to each of these substances is given in terms of the millimols of substance diffusing through 1 sq. mm. of surface under 1 mol osmotic pressure in one hour.

TABLE 6.—*Permeability of Rabbit's Lens Capsules to Water, Dextrose, Sucrose and Raffinose; Determination After One-Half Hour of Diffusion*

Rabbit; Age	Capsule No.	20 Cm. Hydrostatic Pressure; Water Flow ½ Hour	5% Dextrose		5% Sucrose		5% Raffinose	
			Water, C.Mm.	Dextrose, Mg.	Water, C.Mm.	Sucrose, Mg.	Water, C.Mm.	Raffinose, Mg.
6 to 12 months	1	0.8	3.8	2.76	4.5	1.60	4.9	1.28
			3.9	2.84	3.6	1.51	4.1	1.15
			3.7	2.72	4.2	1.50	4.5	1.15
	2	1.13	4.6	2.92	4.0	1.52	5.0	1.22
			4.2	2.69	4.8	1.59	5.6	0.98
			5.8	2.99	4.6	1.59	3.2	1.01
	3	3.1	4.1	2.89	5.0	1.59	4.4	1.34
			7.1	2.44	6.5	1.67	4.9	1.34
			6.0	2.69	5.8	1.71	5.1	1.34
	4	...	5.4	3.00	4.8	2.02	4.6	1.30
			5.0	2.90	4.9	1.89	4.1	1.30
			4.6	3.42	4.5	1.91	4.6	1.32
	5	1.0	5.2	2.89	4.5	1.58	4.1	1.13
			5.6	3.06	5.3	1.76	...	....
			5.5	2.91	5.1	1.76	...	....
	6	1.8	5.1	2.90	5.5	2.03	4.9	1.23
			5.3	2.90	5.4	2.12	5.2	1.18
			5.0	2.89	5.1	2.68	5.0	1.20
18 months	1	1.2	3.4	3.04	3.1	1.95	...	....
			3.7	3.08	3.2	2.12	...	....
			4.7	2.75	3.5	2.00	...	....
	2	1.2	5.0	3.06	3.3	1.96	4.8	1.32
			5.0	3.21	6.2	2.00	5.2	1.21
			5.0	3.04	6.1	2.10	4.6	1.21
	3	2.3	4.9	2.05	4.7	1.23	3.0	1.15
			4.7	2.09	4.2	1.35	3.1	1.09
			3.2	2.09	3.8	1.45	5.4	0.96
	4	1.0	4.2	2.03	3.3	1.33	2.5	1.09
			3.5	2.41	3.3	1.43	2.7	0.92
			4.1	2.43	2.7	1.25	5.8	0.94
	5	2.1	5.6	2.37	4.6	1.27	3.8	1.18
			4.3	2.08	3.7	1.41	3.7	1.18
			4.6	2.14	4.3	1.25	3.9	1.03
30 months	1	...	3.2	2.37	4.4	....	5.2	Trace
			3.5	2.10	3.9	1.42	4.3	Trace
			3.2	1.86	4.1	1.35	4.3	Trace
	2	...	4.3	2.08	4.1	1.35	3.9	0.90
			4.0	2.37	3.8	1.40	5.3	0.94
			4.2	2.36	4.1	1.30	4.1	0.90

TABLE 7.—*Rabbit's Lens Capsules*

Age	Water	Dextrose	Sucrose	Raffinose
Relative Molar Permeabilities				
6 to 12 months	1.0	0.0645	0.0262	0.00828
18 months	1.0	0.0565	0.0236	0.00753
30 months	1.0	0.0491	0.0202	0.00617
Relative Change in Permeability with Age				
6 to 12 months	1.00	1.00	1.00	1.00
18 months	1.00	0.88	0.90	0.91
30 months	1.00	0.76	0.77	0.75
Permeability in Milligram Mols per Mol Osmotic Pressure, per Sq. Mm., per Hour				
Average all ages	55.4	3.27	1.35	0.425

The experiments show a steady and continuous decrease in permeability with advancing age. The fact that the relative decrease in permeability for all three sugars is approximately the same indicates that the pore size of the membrane even in aged (not cataractous) rabbits remains considerably larger than the size of the largest sugar molecules used in our tests. This is in accord with our previous observations, which showed that the lens capsules of old animals were still permeable to some colloid aniline dyes.

SUMMARY AND CONCLUSIONS

A study of the permeability of lens capsules obtained from the eyes of cows, calves, pigs and rabbits, to water, dextrose, sucrose and raffinose revealed the following facts:

1. The permeability of the capsules from adults of all three species is of the same order of magnitude.

2. The permeability of the capsules decreases with age.

3. The permeability of the capsules decreases with increasing molecular weight of the diffusing substances.

OCULOGYRIC CRISES IN POSTENCEPHALITIC STATES *

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AND
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OMAHA

Of all the bizarre residual encephalitic manifestations, probably none is more inexplicable than the oculogyric crises. In earlier epidemics of encephalitis, eye symptoms were very prominent; now we see an increasing number of patients with parkinsonian residuals accompanied by late manifestations of the eyes. The name oculogyric crises has been given to the syndrome in which paroxysmal spasmodic deviations of the eyeballs occur, either upward, downward or laterally. The eyes become fixed in one plane, frequently with a fluttering or an involuntary forced closure of the eyelids.

Although the neurologic literature for the past five years is replete with reported cases and discussions, we believe that the ophthalmologist and the internist have not been sufficiently informed concerning this disorder.

This report will collate the observations of the late Dr. Harold Gifford's [1] and Dr. G. Alexander Young's offices on seven cases presented to us during the past two years. In the report we shall not attempt to review the literature on the subject. For further information the reader should consult the excellent studies of Jelliffe,[2] who has assembled all the reported cases in a series of articles prepared for a monograph. He found 200 cases reported in the literature up to 1929.

The clinical symptoms consist entirely of attacks of deviation of the eyeballs upward, laterally to the right or left or downward, lasting from several minutes to several days. At times the eyeballs remain fixed in these planes or can be controlled for a moment, only to return to the unusual position until the attack has ceased. Fluttering or blinking movements of the eyelids are common, and distressing involuntary closing of the eyelids frequently occurs. There are often accompanying synergistic movements of the head and body with the attacks.

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* From the Departments of Neurology and Ophthalmology of the University of Nebraska College of Medicine.

1. Dr. Gifford was very much interested in this syndrome at the time of his death, and it was his suggestion that our series of cases be reported.

2. Jelliffe, Smith Ely: Psychologic Components in Postencephalitic Oculogyric Crises, Arch. Neurol. & Psychiat. **21**:491 (March) 1929; Oculogyric Crises as a Compulsion Phenomenon, J. Nerv. & Ment. Dis. **69**:194, 1929.

Usually there is marked discomfort of the eyes, with pulling sensations in the eyes and head during or following the attacks. Trancelike states may accompany the attack, and emotional disturbances of markedly anxious type are frequent. The emotional component of fear in the attacks has caused many observers to speak of a hysterical element in the patients.

The disorder is usually seen in a parkinsonian state, but this is not a necessary state, as one of our patients showed no paralysis agitans residual of encephalitis, yet he was definitely postencephalitic.

Any pathologic explanation of the disorder is hypothetic, since no necropsy studies have been reported. Most authors consider the origin to be in the basal ganglions or the striopallidal system. Some believe that the anterior part of the corpora quadrigemina is the seat of the pathologic condition.

Jelliffe has attempted to work out an organic and psychogenic origin for the seizures. His studies have been directed particularly toward the anxiety elements of fear in his patients as present in the attacks. These he considers were conditioned by an unconscious sense of guilt. His reasoning seems good, that there are organic pathologic changes with an overemotional response producing the spasms of the eyes. Furthermore, while the symptoms of the eyes frequently come on unexpectedly without warning, many patients are prone to attacks after emotional stress or fatigue. These factors may be sufficient to produce a release phenomenon of the controlling coordinating centers of the eyes. But the same affective disorders, usually of anxious type, are seen in other postencephalitic states; in fact, these emotional changes are a characteristic symptom of previous encephalitic infection.

REPORT OF CASES

The following case reports are those of patients suffering from oculogyric crises who have come under our observation.

CASE 1.—*Clinical History.*—Mr. J. K., aged 24, was referred to Dr. G. A. Young on June 5, 1928, complaining of the eyes turning over: "If I look up, they stay that way; if I look down, they stay down."

In about 1922, the patient had had mumps complicated by a delirium that required restraint in bed for one week. The illness, which the attending physician called chorea, lasted one month. In 1924, for about two months the patient was troubled with swimming sensations in the head. In September, 1925, while he was looking upward trying to catch a baseball both his eyeballs turned upward and remained so for about one and one-half hours. From that date spells of sudden forced upward or downward conjugate deviation of the eyes began to occur more frequently, recurring every few weeks, always appearing in the afternoon and usually lasting until bedtime. During the attacks, the patient felt restless and walked a great deal. He believed that the attacks came from worry about himself. Following each attack the eyes were painful, and frontal headache lasted for about

twenty minutes. In addition to the distress in the eyes, the patient stated he was more clumsy in muscular movement than formerly and usually had an increased desire to sleep, though at times he had trouble in sleeping. The mood was depressed and worried. He had been unable to work and had been discharged from the navy on account of the trouble in the eyes. Of late the patient had preferred to remain by himself and had been more self-conscious. He worried over masturbation and blamed the condition of the eyes on it. No relationship between onanism and the first attacks was found.

Examination.—Neurologic examination gave entirely normal observations, no evidence of parkinsonian residual being present. The general physical examination gave negative results, except for a colloidal gold curve of 1234431000.

At the time of the first ophthalmologic examination in 1926, the vision of each eye was 20/30 +, improved to 20/15 in each eye with a + 0.25 sphere. In 1928, the vision was 20/15 without glasses. The reaction of the pupil, the visual fields and the fundi were normal. The only ocular condition was the oculomotor phenomenon mentioned.

Progress.—Various methods of treatment were tried. Amyl nitrite inhaled during the attacks was ineffectual. Suggestive psychotherapy in the form of strong faradic stimulation during the attacks was not successful. Phenobarbital gave no relief. The taking of continuous hyoscine hydrobromide much alleviated the frequency and severity of the attacks. The patient was observed on numerous occasions during his seizures. There was usually marked apprehension. Early in the attack, when the eyes deviated upward, the patient could move them down momentarily, but as the attack progressed the eyes would remain upward. Jerky nystagmoid movements were present at the same time that the eyelids would be in a rhythmic spasm. The subjective sensation was that of the eyes "turning over." The entire attack lasted about thirty minutes.

Tonsillectomy was performed, and the patient was given an intensive course of nonspecific protein shocks with intravenous typhoid vaccine, similar to the treatment in multiple sclerosis.[3] There was little or no improvement in the condition of the eyes. Tincture of stramonium, as well as hyoscine, in physiologic doses did not relieve the condition. The patient is at present able to work practically full time at manual labor.

CASE 2.—*Clinical History.*—Mrs. O. S., aged 22, was referred to Dr. Harold Gifford on June 27, 1929, complaining of upward spasmodic movements of the eyeballs. The past history was unimportant until after an accidental abortion in 1927, when the first trouble with the eyes began. The attacks, infrequent at first, occurred almost daily at the time of examination. During each attack the eyeballs deviated upward; the patient could bring them down momentarily at first, but could not keep them down. The attack would continue until she lay down and slept. She had been more nervous of late and had noticed that nervousness brought on an attack; driving a car would also precipitate an attack. For the past year excessive somnolence had been present.

Examination.—Neurologic and visceral examination gave normal observations, except for a slight fixity of facial expression, which was undoubtedly the facies of encephalitic parkinsonism. No other evidence of postencephalitic residual was present.

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3. Young, G. A., and Bennett, A. E.: Non-Specific Protein Therapy of Disseminated Sclerosis, Nebraska M. J. **12**:401, 1927. Supplement to the Blumer Edition of Billings: Forchheimer Therapeutics, New York, D. Appleton & Company, 1929, chapt. 55.

Ophthalmologic examination revealed: Vision reduced to 4/200 in the right eye due to a high degree of hyperopia with some astigmatism, the correction of which improved her vision to 20/70. The vision of the left eye was normal. There was an esophoria of 3 degrees and a left hypophoria of 2 degrees. She complained of a feeling of heaviness about the eyes immediately before an attack, but aside from this, the eyes were apparently normal.

Progress.—For a time the patient carried out treatment with hyoscine under the direction of the family physician. A recent report from the patient stated that there had been no improvement in the ocular crises. It is more than likely that the therapy had not been given a fair trial and the drug increased to physiologic dosage.

CASE 3.—*Clinical History.*—Rev. A. N., aged 41, was referred to Dr. Harold Gifford on April 12, 1929, complaining of the eyes turning downward and remaining in this plane until he had rested. He had had a febrile, delirious disease in 1925, during which he was semicomatose for about two weeks. Since that time he had never regained his normal vigor and had continued to feel drowsy. At times double vision was present. The first spasms of the eyes began during 1928; since that time the patient had noted that when looking down he could not raise the eyes. Sometimes when the patient closed the eyes for a moment he could raise them, but they would drop at once. These attacks lasted about fifteen minutes, but if the patient lay down to rest or fell asleep he could raise the eyes within a few minutes. These attacks always came on after he looked down voluntarily.

Examination.—Neurologic examination revealed a characteristic postencephalitic parkinsonian facies, gait and attitude. The physical status was normal.

Examination of the fundus showed a small patch of displaced pigment in the retina of each eye rather symmetrically placed to the nasal side of each optic disk. There was considerable myopic astigmatism with a vision of 20/30 in each eye with correction. The left eye diverged about 10 degrees when fixing with the right, but would rotate inward on fixation with the right eye occluded. The reactions of the pupils and the peripheral fields were normal.

Progress.—We have been unable to learn whether or not this patient was benefited by therapy.

CASE 4.—*Clinical History.*—Mr. W. P. S., aged 31, was referred to Dr. Harold Gifford on March 29, 1929, complaining of spells of the eyes turning to the right and also forced closure of the eyelids. He first noted sluggishness of muscle movements about 1926 and a tendency to drowsiness since that time. The symptoms in the eyes began in 1927, with spells of involuntary forced closing of the eyelids; about six months later the eyes began turning to the right. The patient was unable to control the eyes, and the eyeballs remained outward until he closed the lids or fell asleep. These attacks came on about once a week at the onset, but had become almost daily. He had been unable to hold any steady position on account of the frequency and severity of the spasms of the eyes.

Examination.—The neurologic status showed a moderate degree of encephalitic parkinsonism; the facies, attitude and gait demonstrated the muscular hypertonicity. The physical status was normal.

Aside from the oculomotor disturbances, the eyes were practically normal. The vision corrected to 20/20 in each eye with no abnormalities of the reaction of the pupil, the visual fields or the fundi.

Progress.—On continuous medication with hyoscine the eyeballs could be prevented from turning outward, but closing of the lids continued. The patient was aware of a constant sensation of the eyes wanting to close and also of a flickering

or fluttering sensation of the lids most of the time. Occasionally, the eyes would turn upward but usually the spasmodic deviation would be outward to the right. Suggestive of an emotional component in the disorder was the statement of the patient: "If I can have my mind a blank or forget myself, the eyes come back." The symptoms were always worse while the patient was driving a car. The medication with hyoscine was discontinued to try the effects of a course of protein shock therapy. This was given for about two months without any definite benefit. Tincture of stramonium, increased to 1 drachm (3.9 Gm.) three times a day, relieved the attacks to about the same degree as the treatment with hyoscine.

CASE 5.—*Clinical History.*—Mrs. W. M., aged 33, was first seen on March 2, 1929, during an attack of upward conjugate deviation of the eyeballs. This attack persisted for several hours before abating. She also complained of pain in the eyeballs and a fluttering sensation of the eyelids. The past history was unimportant, except for a spell of lethargy and delirium in 1919, when the patient was ill for about three months. Recovery from this illness was slow, and the patient had felt weak and had become fatigued easily since then. About four or five years before examination the first attacks of upward conjugate deviation of the eyeballs occurred, gradually increasing in frequency and severity until they occurred about three times weekly and lasted at times for twenty-four hours. The pulling sensation in the eyeballs was painful. Fluttering of the eyelids occurred almost constantly. The attacks were accompanied by a feeling of extreme nervousness and apprehension. The family said that the patient had been growing more nervous and had been unable to carry on her household responsibilities for several months.

Examination.—Neurologic examination revealed that the oculogyric attack was typical in every respect; the patient was extremely apprehensive, complaining of the unpleasantness of the seizure and begging for relief. A moderate degree of postencephalitic parkinsonism was present. She was markedly undernourished.

Ophthalmologic examination revealed a moderate degree of myopic astigmatism, but the vision was 20/20 with correction. There was nothing abnormal in the pupillary reflexes or the visual fields, but there was a fine, irregular thinning of the center of each macula which was probably congenital.

Progress.—The patient was placed on a high caloric diet reinforced by the administration of various vitamin preparations. She has been taking hyoscine hydrobromide continuously. She has gained weight and has improved much generally. She states that she is able to control the attacks of orbital spasm almost entirely with the hyoscine and is now able to do all her own housework. This patient obtained the most striking benefit from the use of hyoscine of any patient in the series.

CASE 6.—*Clinical History.*—Mr. H. C. T., aged 28, in 1922 had a nervous attack characterized by a sudden onset of vertigo and insomnia for twenty-four hours, followed by diplopia and delirious lethargy lasting for several days. He took a rest for one year after this illness. About June, 1928, the patient first noted upward conjugate deviation of the eyeballs while reading. The eyes were refracted at this time but about once weekly the attacks continued. The eyeballs would remain in the upward position all day after the attack once began. The attacks became more frequent, finally forcing the patient to discontinue all work. The eyeballs could be controlled momentarily but flew upward again until the attacks ceased spontaneously. He had noted an increasing slowness of muscular movement during late years.

Examination.—On June 3, 1929, neurologic examination gave essentially negative results, except for mildly masked facies and stiffened bradykinetic muscular attitude or postencephalitic parkinsonism.

On June 1, 1929, ophthalmologic examination revealed: The vision of the right eye was 20/70; of the left eye, 20/20. It was improved to 20/15 in each eye by correction of the myopic astigmatism. There was a left hyperphoria of 1 degree, with a marked weakness of the other muscles. The reactions of the pupils, the form, the color fields and the fundi were normal.

Progress.—The patient was given treatment with hyoscine, but he discontinued it. At present, on taking physiologic doses of tincture of stramonium, the patient is obtaining considerable relief from the attacks.

CASE 7.—*Clinical History.*—Mr. E. B., aged 23, had an ill defined illness in 1920, characterized by headache, some distress with the eyes and insomnia. He was ill in bed for one month. In about 1923, the first attack of upward conjugate deviation of the eyeballs occurred. These attacks came about once a week and lasted until the patient went to bed. Of late the attacks had been more frequent, occurring two or three times a week. There was always the upward spasmodic movement associated with marked blepharospasm. Some bitemporal headache was present at times. Emotional stimulation or fatigue apparently precipitated an attack. Marked loss of ambition and slowness of general body muscular movement had developed gradually over a period of years, largely incapacitating the patient from work.

Examination.—On April 15, 1930, neurologic examination revealed a well advanced parkinsonism with characteristic facies, gait and bradykinesia of all movements.

Ophthalmologic examination gave negative results.

Progress.—This patient was given treatment with stramonium under the guidance of the home physician.

COMMENT

In case 1 there was a clearcut history of an acute encephalitis, with seizures typical of oculogyric crises. This patient showed the anxiety components as described by Jelliffe, and the fear panics seemed to precipitate an attack. Ideas of guilt were present in a masturbation conflict. The emotional response in this case was no different from that seen in many other postencephalitic states as part of the general personality change of the patient. A significant feature of the case was the entire absence of evidence of parkinsonian sequelae. Various forms of therapy gave only temporary relief; hyoscine gave the most relief.

In case 2 an encephalitic history was entirely lacking, but a parkinsonian neurologic picture was present. The spasmodic attacks of upward conjugate deviation were typical. This patient had the tendency to fall asleep for relief from the symptom. Other observers have noted this tendency in their patients.

In case 3 an encephalitic history was definite and a paralysis agitans residual was marked. Here again relief from the distress of the eyes was obtained by sleep.

In case 4 the lateral and upward spasms were characteristic. In addition, the most troublesome symptom to the patient had been the involuntary closing of the eyelids with an inability to open them. No acute

encephalitic history was obtainable but a modified parkinsonian residual was present. Both hyoscine and stramonium ameliorate the attacks considerably, but they have not relieved the blepharospasm.

In case 5 the history was typical, and the neurologic observations of a parkinsonian encephalitic state were present. The spasms of the eyes were characteristic and the emotional components prominent. The fluttering and forced closure of the eyelids were prominent symptoms. This patient gained much in a general way from tonic therapy and with hyoscine therapy obtained striking relief from the frequency of the attacks.

Cases 6 and 7 were typical in every respect; both patients had suffered from severe acute encephalitis and were left with parkinsonian residuals, including oculogyric crises.

SUMMARY

Seven typical cases representing the syndrome of oculogyric crises, postencephalitic, are reported. In six patients modified parkinsonian residuals were present, but a seventh patient was not parkinsonian. The spasmodic conjugate deviation of the eyeballs was present in all. In addition, most of the patients presented the symptoms of involuntary, forced closure of the eyelids with blepharospasm. The conjugate deviation is rather constantly accompanied by fluttering or flickering of the lids.

Various therapeutic measures were tried, but no definite improvement was seen except in the use of continuous medication with hyoscine or stramonium, which usually gave some relief. One patient improved markedly with general constitutional treatment and the administration of hyoscine. Tincture of stramonium in physiologic dosage gave no additional palliative relief from the attacks over the hyoscine, but in some instances apparently relaxed the bradykinetic tendency more strikingly than hyoscine. Both of these drugs are much worth while and should be administered; they often permit a completely incapacitated patient to return to work. No tendency to spontaneous cure has been observed in this series.

UNRECOGNIZED RETINOBLASTOMA AND PSEUDORETINOBLASTOMA

REPORT OF CASES *

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A report of an unrecognized case of retinoblastoma (Verhoeff), generally known as glioma retinae, and another of a pseudoretinoblastoma, are of diagnostic value, as similar cases have only occasionally been recorded in the literature. The unusual histories and clinical features presented by the patients are described. The patients were brought to the Manhattan Ear and Eye Hospital within a short period of each other. In each case, the history and the manifestations of the eye suggested a diagnosis in which several ophthalmologists concurred; nevertheless, neither was confirmed by the microscopic diagnosis.

Retinoblastoma is a rare condition, especially in the colored race. On request, Dr. E. Phinizy Calhoun kindly sent me the following report concerning the frequency of glioma of the retina in colored infants at the Grady Hospital, Atlanta, Ga.: "I find that the records show only one case since 1921, out of 49,036 patients. The eye in this case was removed and the diagnosis confirmed by sections."

REPORT OF CASES

CASE 1.—*History and Course.*—G. P., a colored boy, aged 2, was brought to the clinic, April 3, 1929, by a social worker, as the mother was in a general hospital suffering with pulmonary tuberculosis. The mother had stated that her infant's health, including that of its eyes, had never been affected until the child was vaccinated on the arm against smallpox. Three days after the vaccination, the right eye suddenly became red and swollen, and about the same time a blister appeared on the surface of the right foot.

During the examination at the clinic, the child was fretful and showed some increase in temperature. On the right arm were dry crusts over the site of the vaccination performed several days previously, and there was also a vesicle on the dorsum of the right foot. The left eye was normal.

The right eye showed a slight swelling of the lid, painful on palpation. Blepharospasm and serous secretion were present. The ocular conjunctiva was markedly chemotic; motility of the eyeball was not interfered with. The intraocular tension was reduced. The cornea seemed normal; the anterior chamber was deep, and the aqueous was turbid and contained a hypopyon. The markings of the iris were indistinct; the pupil was circular and central and did not react

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to light either directly or indirectly; the eye was completely blind. Focal illumination of the vitreous was not possible, partly owing to the cloudy aqueous.

From the history and acute manifestations of the eye, a diagnosis of metastatic ophthalmia was made and confirmed by other ophthalmologists, and the child was sent into the hospital for a complete physical examination, to be followed by an enucleation, since the eye was irreparably blind and would otherwise eventually result in a phthisis bulbi with its sequelae.

On admission into the hospital, examination revealed that the child was well nourished and, in addition to the ocular ailment, had a mild bronchitis, and hypertrophied tonsils and adenoids. Blood cultures and cultures taken from the vesicle on the foot were negative. The Wassermann reaction of the blood and the urine was also normal.

After the patient had been in the hospital two days, the statement was again procured from the mother that the child had had none of the diseases of childhood, that he had never been sick before, and that the condition of the right eye had started three days following the vaccination by the board of health physician, March 17, 1929. When the condition of the eye became aggravated, the social worker was notified, and she brought the child to the clinic. The mother had two other children, a boy, aged 3 years, and a girl, aged 6 months, both in excellent health.

While the child was in the hospital the general condition improved, but the condition of the eye remained stationary despite local treatment. After he had been in the hospital three days, a hemorrhage appeared in the aqueous, without causing any increase in the intra-ocular pressure. The presence of a retinoblastoma was then first considered, as hemorrhages are frequent in retinoblastomas and are rare in metastatic ophthalmia. Enucleation was then performed, and the eye was placed in solution of formaldehyde for study and report. While the child was under the general anesthetic, the left fundus was examined and found to be normal.

The general condition improved markedly after the operation. A week later, the adenoids and tonsils were removed, and the patient was discharged in excellent condition, May 2. The child was reexamined a year later and showed no evidence of any recurrence or of any involvement of the fundus in the left eye.

Pathologic Study.—The enucleated eye was of normal size and shape. The sclera was thinned, mainly posteriorly. On manipulation, the sclera became indented. The eye was then placed in solution of formaldehyde. After fixation of the eyeball, it was bisected with a razor; during the process, a gritty sensation was perceptible; this sensation was due to calcium deposits in the tumor, which occupied the vitreous. (Had a roentgen examination of the eye been made before its removal, these deposits would probably have been shown.) The gross appearance of the tumor resembled brain tissue. Celloidin sections were made and stained with hematoxylin and eosin.

Microscopic examination under low power (fig. 1) showed that the main lesion was a necrotic tumor occupying practically the entire vitreous. The tumor consisted of numerous deeply bluish stained cell aggregations in the vicinity of the blood vessels. These cells had a definite pseudoroset formation, no true roset formation being recognized. Between the accumulated neoplastic cells were intervening degenerated areas that took on a poorly pinkish stain. These areas consisted of coagulated albumin. Others contained detritus, pigment granules, numerous blood vessels, hemorrhagic areas and empty spaces which had contained calcium deposits, accompanied by mild evidences of inflammation.

Microscopic examination of the tumor with a higher magnification (fig. 2) showed accumulation of variously shaped compact nuclei, with barely any cytoplasm or intercellular substance. Some of the cells were irregularly outlined; others were round and oval; many cells contained deeply stained chromatin material and others were vascular; numerous mitotic figures were seen, indicating rapid growth of the tumor. Some of the neoplastic cells were clustered around vascular channels containing red blood cells and lined by an endothelial layer of cells, the neoplastic cells forming a perivascular pseudoroset (fig. 3). Palisade formation of neoplastic cells was also observed. Migration and extension of the neoplastic cells were seen in all the ocular cavities (illustrated in figure 4, in the anterior chamber). A thin membrane was seen lining the posterior surface of the iris and ciliary body which extended over the anterior portion of the vitreous behind the lens. This membrane was studded with pigment granules and neoplastic cells which interfered with the observation of the tumor in the vitreous.

The retina was entirely replaced by tumor tissue and the choroid also, except for a small portion which was infiltrated with neoplastic cells, pigment, hemorrhage and connective tissue. The sclera was thinned out as a result of the pressure of the tumor. The optic nerve was not involved. The retro-orbital tissue around the optic nerve showed slight evidences of inflammation.

The anterior segment of the eyeball showed evidences of acute and chronic inflammation, proliferation and migration of pigment, and neoplastic and epithelial cells. The anterior ciliary vessels contained and were surrounded by inflammatory cells. The iris was markedly atrophic, and its stroma was infiltrated with pigment. The retinal pigment extended over its anterior surface. The ciliary body was atrophied, showing absence of ciliary processes. The zonular fibers were covered with clumps of pigment and neoplastic cells.

The microscopic diagnosis was retinoblastoma with sequelae.

The posterior chamber was filled with coagulated albumin and red blood cells. The lens and the iris were displaced posteriorly, because of the large amount of coagulated albumin and numerous red blood cells in the anterior chamber. The peripheral angle of the anterior chamber contained pigment granules and neoplastic cells simulating a hypopyon. The root of the iris was adherent to the cornea, causing obliteration of the peripheral angle of the anterior chamber. (This condition usually produces increased intra-ocular pressure, but it was not present, probably owing to the counteracting effect of the pathologic involvement of the secretory and vascular structures of the eye.) The lens appeared normal, but it was displaced posteriorly. The cornea was normal, but on its posterior surface were clusters of migrated neoplastic cells without a central vascular channel, forming pseudorosets (fig. 4).

This case illustrates the difficulty in diagnosing the primary lesion of the eye involvement from the history obtained and the acute manifestations. The latter caused a turbid aqueous which, in conjunction with the vitreous membrane, prevented observation of the retinoblastoma. Also it illustrates that under similar conditions retinoblastoma should be considered.

The occurrence of necrosis in retinoblastoma is a characteristic feature. This necrosis is considered by some authorities to liberate toxins which cause an iridochoroiditis. Others assert that the acute inflammation of the eye is brought about by local recurrence of the growth.

It is impossible to state what influence, if any, the vaccination had either in causing the iridochoroiditis or in stimulating tumor necrosis.

Hemorrhage is frequently observed in retinoblastoma. Its appearance in the aqueous was due to the hemorrhage from the tumor diffusing into the aqueous. When seen, it aroused the suspicion of an existing retinoblastoma.

The retinal gliomas are characterized by rosets, variously named. Flexner's term is "neuro-epithelioma retinae.". The cells of the rosets are considered to be embryonic rods and cones, hence the term neuro-epithelioma. Others regard these cells as undifferentiated embryonic cells, representing the germ of the tumor. On the other hand, some authorities state that it is most probable that the cells of the rosets are primitive spongioblasts, comparable to the cells of Mueller—perhaps at times embryonic rods and cones. The term retinoblastoma, suggested by Dr. Verhoeff, was adopted by the American Ophthalmological Society in 1926 as being the most appropriate name for the so-called glioma retinae.

CASE 2.—*History and Course.*—J. F., a girl aged 3 months, was brought by her mother to the clinic, Oct. 17, 1928, on account of a yellowish-brown glare emanating from the pupil. The mother was 28 years old and in normal health. She had had three children, losing one three days after birth following an operation on a hydrocephalic head. The second child, 4 years old, was in perfect health. The third child was the present patient.

The child was born, July 25, 1928, following a normal pregnancy and delivery. The mother said that in the sixth week of her pregnancy she fell on her feet from a height of 9 feet; this accident did not cause any ill effects. After birth, the child was examined by her physician, who reported that it was perfectly normal, but a few days later it went into a coma for two days, refused to swallow liquids, and held its head to one side; when the head was straightened, it caused pain. The physician could not account for the child's condition, and consulted a pediatrician, who also could not account for the symptoms. Ocular and neurologic examinations were negative. The physicians then decided to send the child into a general hospital for a roentgen examination of the spine and the skull. This examination also proved negative. The upper part of the spine was then placed in a starch bandage to support the head. After two weeks the bandage was removed. The child's appetite and the position of its head then improved, although it cried continuously day and night. Now, for the first time, the physician and mother noticed the yellowish appearance of the left pupil. The physician then advised the mother to bring the child to the clinic.

During the examination, the infant was unusually fretful. With the exception of the condition of the eyes, it appeared to be normal. The right eye showed a moderate horizontal nystagmus and a grayish-white optic disk; otherwise it was normal. (It is possible that the discoloration of the disk was of congenital origin or due to a partial optic atrophy.) The pupil reacted to light and followed the light in all directions, indicating vision.

The left eye appeared normal, aside from the yellowish-brown pupillary reflex. The intra-ocular tension was increased; the cornea and aqueous were clear; the anterior chamber was shallow as compared with that of the opposite

eye; the iris appeared normal but did not react to light either directly or indirectly. The pupil was widely dilated, circular and central. Focal illumination of the vitreous showed a yellowish-brown reflex due to a smooth nonvascular mass located directly behind the lens. Transillumination was absent. The eye was blind. In the dark room, this pupil had the appearance of the so-called amaurotic cat's eye.

On the basis of these clinical eye manifestations, and in conference with several other ophthalmologists, the condition was diagnosed as a retinoblastoma and enucleation was advised, to which consent was given. The infant was admitted to the hospital on Oct. 20, 1928. After enucleation the eye was placed in solution of formaldehyde for future study and report.

Pathologic Study.—The enucleated eye appeared normal in every respect except for the yellowish-brown pupillary reflex. Following this examination, the eye was placed in solution of formaldehyde. After fixation, it was cut and then embedded in celloidin. Sections were made and stained with hematoxylin and eosin. Examination of the gross specimen after bisection showed a form of pseudoretinoblastoma but no evidence of a retinoblastoma. This lesion consisted of a mass of dense tissue located behind the lens and extending from the center, where it was thickest, posteriorly to the papilla and laterally to the ora serrata. This dense tissue divided the vitreous into two equal compartments.

From the gross appearance, my co-workers and I believed that we were dealing with a persistent posterior pupillary membrane and hyaloid artery due to a hyperplasia of mesodermal tissue. This conception of the tissue, however, was not verified by the microscopic examination.

Study of the Section.—The low power examination of the section (fig. 5) showed mainly a cyclitic membrane and a consecutive proliferating retinitis. (These conditions clinically resembled a retinoblastoma and were so diagnosed.) The region apparently most involved was around the papilla (fig. 6), where a detachment of the retina was seen. This detachment occurred where there was a massive hemorrhagic infiltration. In this area were also seen newly formed connective tissue (retinitis proliferans), many fibroblasts, a large amount of blood pigment representing a recent hemorrhage, polymorphonuclear leukocytes, monocytes, and occasional plasma cells. In the immediate vicinity of the hemorrhagic foci was a marked edema. The entire inflammatory tissue was sharply marked off from the retinal structure proper. At the opposite end of the inflammatory tissue and continuing forward were two distinct, linear-shaped masses of an amorphous and fibrinous material, leading to the zonular fibers and ciliary processes forming the cyclitic membrane. This membrane was fringed with an accumulation of red blood cells and occasional endothelial and plasma cells. The cyclitic membrane was mainly in the stage of resorption, while the connective tissue posteriorly was in the formative stage. No hyaloid vessel was seen in the section. The retinal surface in a few areas was covered with collections of red blood cells; otherwise it was normal, except over the detached portion, where it was folded and the layers were fused together and proliferated. Behind the detachment was coagulated albumin.

In the choroid were small foci of hemorrhagic infiltrations separated from one another by edematous tissue; the vessels contained many polymorphonuclears. The optic nerve showed an increase of neuroglia. The ciliary body was edematous and detached, as the result of a contraction of the cyclitic membrane; the ciliary processes were small. There was no marked inflammatory reaction in the ciliary body. (A marked reaction was not essential for the formation of a cyclitic membrane.) The normal structure of the iris was affected by an increase of the

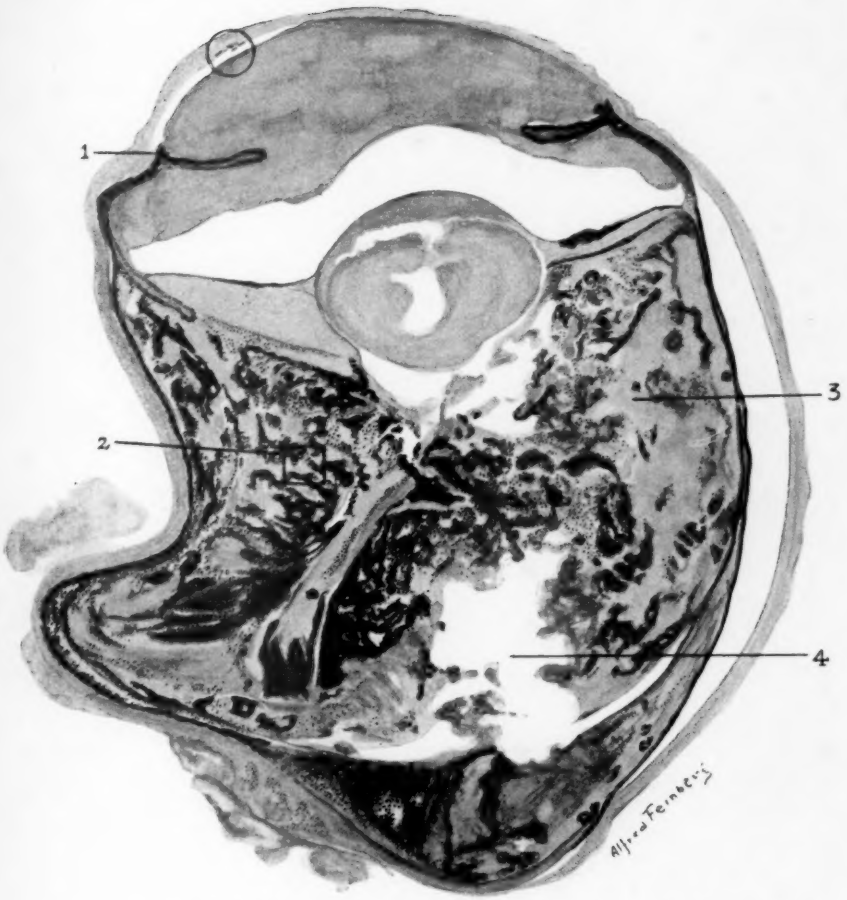

Fig. 1 (case 1).—Retinoblastoma (glioma retinae): Low power drawing of horizontal section of eye. The false sinus angle is shown at 1; the viable cells (2) stain blue; the necrotic tissue (3) is pink; the ragged hole (4) was filled with calcified masses.

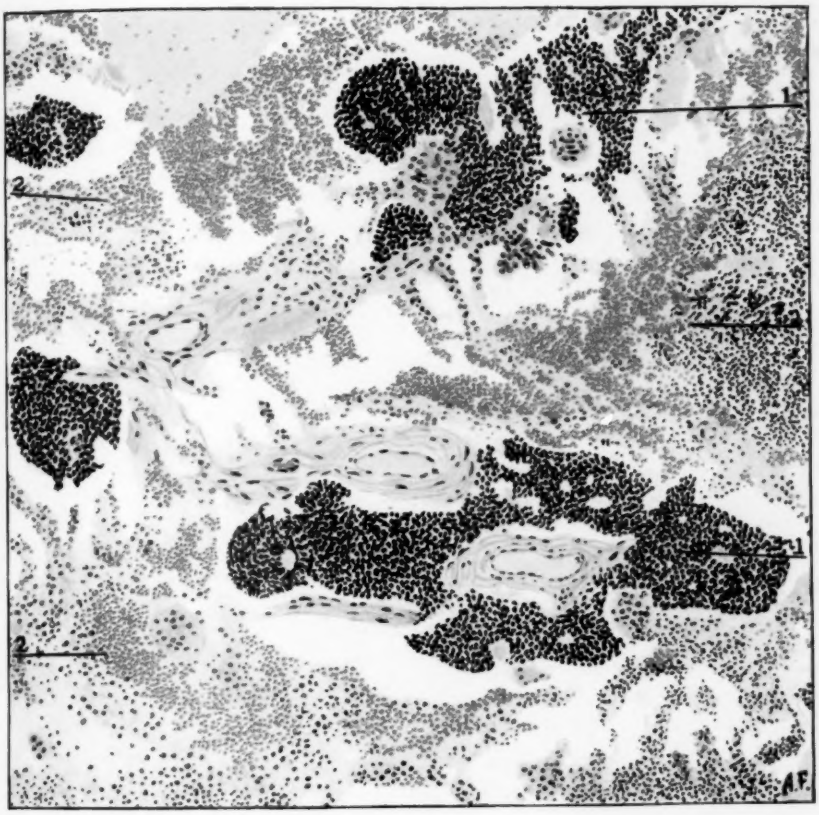

Fig. 2 (case 1).—Appearance under high power of tumor in square in figure 1, showing the mantles of tumor cells about the blood vessels (1), and necrosis and hemorrhage (2).

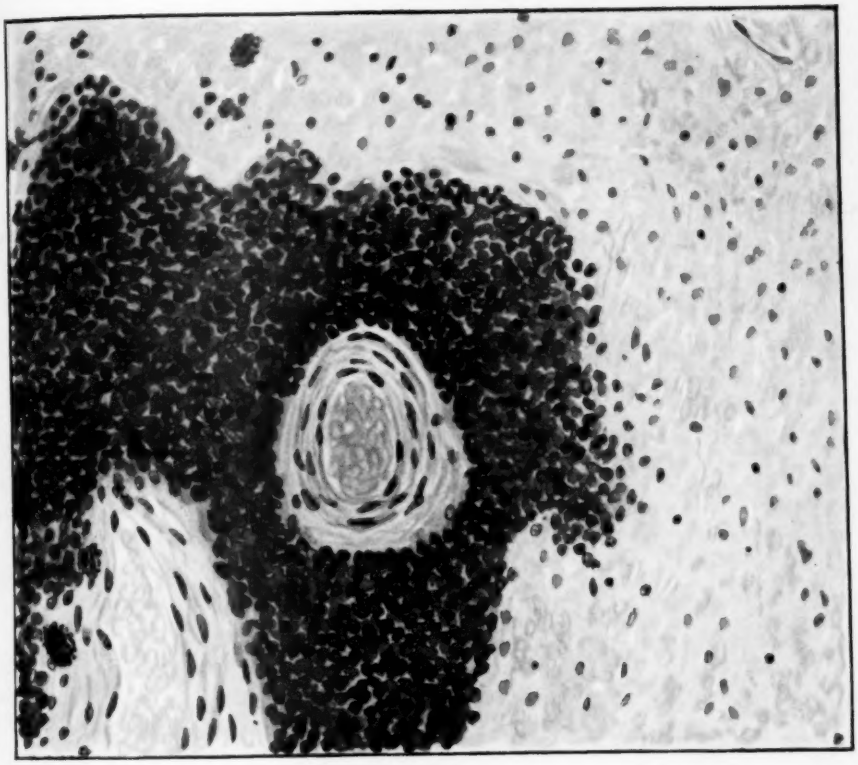

Fig. 3 (case 1).—High power drawing showing perivascular pseudoroset.

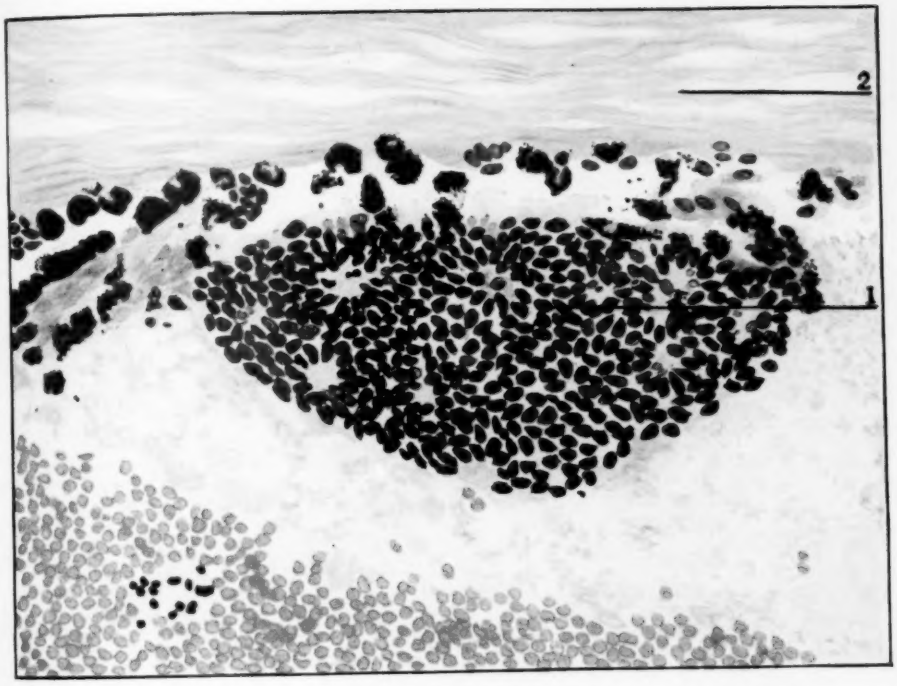

Fig. 4 (case 1).—Higher power of tumor cell clump on cornea (in circle in figure 1).

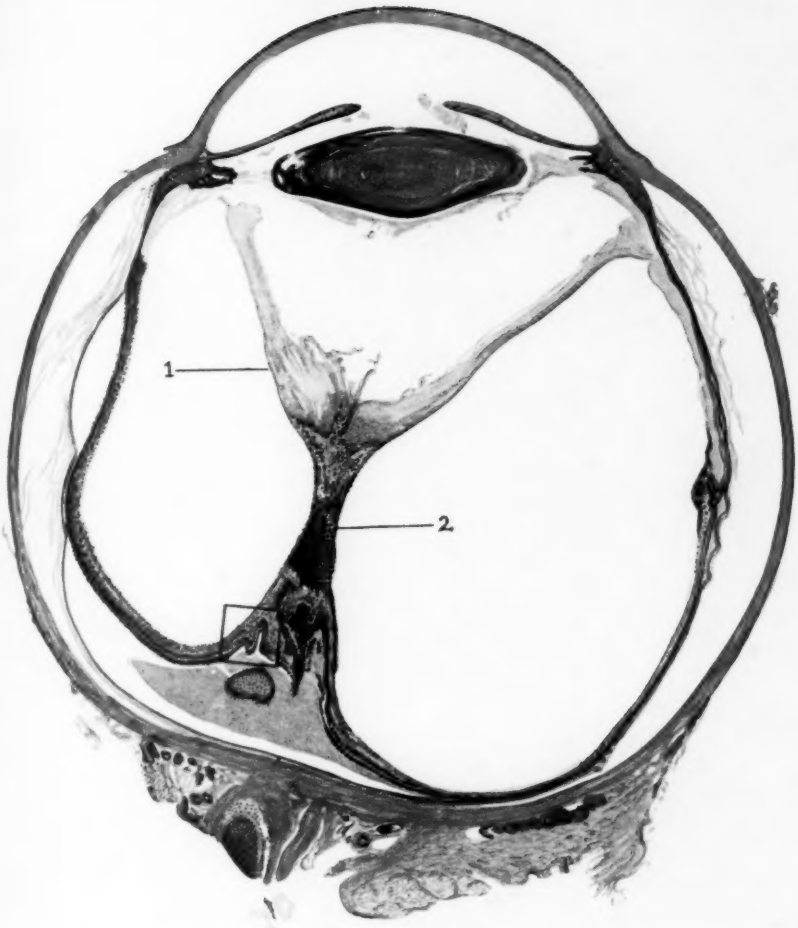

Fig. 5 (case 2).—Pseudoretinoblastoma: Low power drawing of horizontal section of eye. 1, cyclitic membrane; 2, retinitis proliferans.

Fig. 6 (case 2).—High power drawing of area in square in figure 5. 1, scar tissue membrane; 2, detached and folded retina.

connective tissue. The peripheral angle of the anterior chamber was slightly obliterated. Schlemm's canal was compressed. The lens was flattened, and the cornea was normal.

The microscopic diagnosis was plastic cyclitis with cyclitic membrane, and consecutive retinitis proliferans with retinal detachment.

COMMENT

The manifestations of the eye were typical of a retinoblastoma, although the microscopic diagnosis was plastic cyclitis with sequelae, indicating that a pseudoretinoblastoma (plastic cyclitis) may clinically closely resemble a retinoblastoma.

Cyclitis in infants is generally of infectious origin. In this case the source of infection was obscure and could not be determined.

According to the microscopic study there were two inflammatory foci in the eye; one in the ciliary region and the other about the papilla. The anterior one was a milder infection, in the stage of absorption, while the posterior focus was more recent and was formative, producing young connective tissue which in contracting caused the retinal detachment.

In cyclitis of the type reported, it was impossible to exclude a retinoblastoma, and the pseudoretinoblastoma would have terminated in phthisis bulbi with complications, either condition necessitating an enucleation.

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Ophthalmologic Review

THE BIOCHEMISTRY OF THE AQUEOUS, LENS AND VITREOUS *

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A large volume of work has been done during the last four or five years in biochemical studies of the three refractive media of the eye: the aqueous, the lens and the vitreous. One wonders why such studies were not made earlier, and what are the chief factors responsible for the sudden interest in these investigations. According to the older view among ophthalmologists, there is no direct communication between the ocular humors and the blood stream. The aqueous, which is supposed to be in part the medium through which the lens and the vitreous obtain nourishment, was regarded as a secretory product of the ciliary body. As blood is the chief agent of transfer in the body, many physiologic phenomena are interpreted in terms of blood chemistry. But, since no direct relationship was apparent at that time between the blood and the ocular humors, no information could be expected from a biochemical study of the latter. When Ask,[1] however, published the results of his studies on the sugar content of the aqueous of rabbit eyes under varying degrees of experimental hyperglycemia and showed that changes in the sugar level of the blood are readily reflected in the aqueous, a different conception of the origin of the aqueous was at once suggested. Later, Wessely [2] pointed out the intimate relationship between the aqueous and the blood stream. By the instillation of physostigmine (eserine) into rabbits' eyes, he produced marked hyperemia of the capillaries of the ciliary body and the iris. A subsequent analysis of the aqueous for protein revealed an appreciable increase in this constituent. Wessely ascribed it to infiltration from the blood. Landis and Adler,[3] seven years later, repeated the work of Wessely on cats' eyes. Their results led them to the same conclusion. More recently, Duke-Elder [4] carried

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1. Ask, F.: Biochem. Ztschr. **59**:1, 1914.
2. Wessely, K.: Centralbl. f. prakt. Augenheilk. **37**:303, 1918.
3. Landis, E. M., and Adler, F. H.: Protein Content of Aqueous Humor, Arch. Ophth. **54**:265 (May) 1925.
4. Duke-Elder, W. S.: Biochem. J. **21**:63, 1927.

out similar experiments in a slightly different way. He produced hyperemia in a rabbit's eyes by the use of ultraviolet and infrared rays. Refractometric analysis of the aqueous of both the irradiated and the normal eyes showed likewise a pronounced increase in the protein content of the irradiated eye. Furthermore, Duke-Elder studied in rabbits' eyes the effect of changes in the sugar level of the blood on the sugar content of the aqueous as Ask had done several years before. It was once again demonstrated that changes in the sugar content of the aqueous followed closely those of the blood. The most recent work along the same line and with similar results was carried out by Kronfeld.[5] A diet rich in alkali was fed to one group of rabbits, while another group received a diet deficient in alkali. Analysis of both the plasma and the aqueous of the two groups of rabbits for carbon dioxide content revealed a difference in the alkali reserve of the two aqueous humors that paralleled that of the plasma of the two groups of animals. However, in all these experiments it was observed that a certain period of time always elapsed between an observable change in the composition of the blood and that of the aqueous. One would thus expect that the chemical composition of the aqueous in general is determined by that of the blood and the physical and physiologic properties of the membrane between the two fluids.

A comparison of the recent chemical data on the ocular humors with those on serum shows that these fluids are identical in their chemical composition; they differ only in the relative amounts of their chemical constituents.

CHLORIDES (ESTIMATED AS SODIUM CHLORIDE)

Animals.—Five determinations carried out by Rados[6] on the primary aqueous of rabbit eyes gave an average figure of 0.633 per cent. The average figures for the secondary and tertiary (reformed) aqueous of the same rabbit eyes were 0.518 and 0.547 per cent, respectively. The secondary and tertiary aqueous were withdrawn for analysis from one to forty-eight hours after the first puncture. Duke-Elder,[4] working also with rabbits, compared the sodium chloride values of the aqueous, arterial plasma and venous plasma. He found the following average values: aqueous, 0.641 per cent; arterial plasma, 0.59 per cent; venous plasma, 0.551 per cent. On another group of rabbits, he obtained an average value of 0.605 per cent for the primary aqueous and 0.53 per cent for the secondary aqueous. According to Ascher's[7] work on rabbits, the results are as follows: primary aqueous, 0.639 per cent; sec-

5. Kronfeld, P.: Arch. f. Ophth. **118**:606, 1927.
6. Rados, A.: Arch. f. Ophth. **109**:342, 1922.
7. Ascher, K. W.: Arch. f. Ophth. **107**:247, 1922.

ondary aqueous, 0.627 per cent; tertiary aqueous, 0.636 per cent. The secondary humors were obtained within one hour; the tertiary (one sample) was obtained twenty-four hours after the first puncture.

The following tabulation of the foregoing data gives a summary of the results obtained by different authors on the sodium chloride content of rabbit aqueous and serums:

TABLE 1.—*Sodium Chloride Content of Rabbit Aqueous and Serums*

Author	Aqueous			Serum or Plasma	
	Primary, per Cent	Secondary, per Cent	Tertiary, per Cent	Arterial, per Cent	Venous, per Cent
Rados	0.633	0.518	0.547	.....	.....
Duke-Elder	0.641	.....	.....	0.590	0.551
Duke-Elder	0.605	0.530	.....	.....	.....
Ascher	0.639	0.627	0.636	.....	.....
Averages	0.630	0.558	0.591	0.590	0.551

The sodium chloride contents of the aqueous and serum of dogs are given by Rados [6] as follows: primary aqueous, 0.598 per cent; secondary aqueous, 0.6 per cent; serum, 0.574 per cent.

The same author found that the primary aqueous of horses' eyes contains 0.68 per cent sodium chloride; the secondary, 0.656 per cent; serum, 0.559 per cent. According to Duke-Elder,[4] the value for the primary aqueous of horses' eyes is 0.712 per cent. According to Magitot and Mestrezat,[8] it is 0.711 per cent. The sodium chloride content of the vitreous of horses' eyes was found by Cohen, Killian and Metzger [9] to be 0.656 per cent. Horse serum contains 0.614 per cent sodium chloride, as given by Abderhalden.[10]

The ocular humors of cattle eyes resemble those of horses in their sodium chloride values. Rados [6] found 0.703 per cent for the primary aqueous and 0.644 per cent for the secondary aqueous. All the following figures for sodium chloride are based on primary ocular humors. According to Bottazi,[11] it is 0.689 per cent for the aqueous of ox eyes. Salit [12] found it to be 0.714 per cent for the aqueous, 0.682 per cent for vitreous (by volume) and from 0.187 to 0.34 per cent (by weight) for crystalline lenses. According to Cohen, Killian and Metzger,[9] the sodium chloride value for vitreous is 0.678 per cent.

8. Magitot, A., and Mestrezat, W., quoted by Baurmann: Arch. f. Ophth. **114**:276, 1924.

9. Cohen, Killian and Metzger: Proc. Soc. Exper. Biol. & Med. **22**:445, 1925.

10. Abderhalden, Emil, quoted by Nagel, W. A.: Handbuch der Physiologie des Menschen, Braunschweig, Vieweg & Sons, 1910.

11. Bottazi, quoted by Scalinci, N.: Arch. f. Augenheilk. **57**:214, 1907.

12. O'Brien and Salit: Biochemical Studies of the Aqueous, Vitreous and Lens, read before the International Ophthalmological Congress at Amsterdam, 1929.

A comparative summary of the foregoing data on the sodium chloride content of the aqueous, vitreous and lens of ox eyes is given in table 2.

The aqueous of pigs' eyes contains 0.705 per cent sodium chloride (Cohen, Killian and Metzger [9]).

Man.—Rados [6] reported an average figure of 0.806 per cent sodium chloride for human aqueous which was obtained from two patients with minor pathologic processes of the eye. Ascher [7] examined the fluids of approximately 125 eyes of various patients with ocular disorders. His average figure for sodium chloride based on twenty determinations selected at random is 0.698 per cent. Ten determinations by Ascher

TABLE 2.—*Data on Sodium Chloride Content of the Aqueous, Vitreous and Lens of Ox Eyes*

Author	Aqueous		Vitreous, per Cent	Lens, per Cent (by Weight)
	Primary, per Cent	Secondary, per Cent		
Rados	0.703	0.644	.....	.....
Bottazi	0.689	.....	.....	.....
Salit	0.714	.....	0.682	0.187-0.340
Cohen et al.	.....	.....	0.678	.....
Averages	0.702	0.644	0.680	0.187-0.340

TABLE 3.—*Comparison of Average Sodium Chloride Values of Human Ocular Humors, Spinal Fluid and Serum*

Author	Aqueous		Vitreous, per Cent	Spinal Fluid, per Cent	Serum, per Cent
	Primary, per Cent	Secondary, per Cent			
Rados	0.806	.....	.....	.....	.....
Ascher	0.698	.....	0.670	0.708	0.552
Ascher	0.692	0.719	.....	.....	.....
Averages	0.732	0.719	0.670	0.708	0.552

on the vitreous of pathologic human eyes gave an average of 0.67 per cent. For the spinal fluid, he obtained an average of 0.708 per cent from five determinations. According to the same author, 0.552 per cent sodium chloride is the average figure for serum. Secondary aqueous drawn between one day and three months after the first puncture, gave an average of 0.719 per cent, which is nearly the same as the average value of 0.692 per cent for the primary aqueous from the same eyes.

A comparison between the average sodium chloride values of human ocular humors, spinal fluid and serum is given in table 3.

The average chloride values of primary aqueous in descending order for the different species studied are: man, 0.735 per cent; pigs, 0.705 per cent; oxen, 0.702 per cent; horses, 0.701 per cent; rabbits, 0.630 per cent, and dogs, 0.598 per cent.

SUGAR

Animals.—Ask,[1] who carried out a great number of experiments on the ocular humors and the blood of rabbits, has published the following results on their sugar values: primary aqueous, 0.14 per cent; secondary aqueous, 0.14 per cent; plasma, 0.14 per cent; whole blood, 0.12 per cent. According to Duke-Elder's[4] work on rabbits, the sugar values are: aqueous, 0.15 per cent; arterial plasma, 0.148 per cent; venous plasma, 0.125 per cent. In a young cat, Ask[1] found the value to be 0.15 per cent for the primary aqueous, 0.15 per cent for the secondary aqueous and 0.13 per cent for whole blood. The average sugar values obtained by the same author from three guinea-pigs are: aqueous, 0.14 per cent;

TABLE 4.—*Data on Sugar Determinations*

Author	Animal	Primary Aqueous, per Cent	Secondary Aqueous, per Cent	Vitreous, per Cent	Serum, per Cent	Whole Blood, per Cent	Lens, per Cent (by Weight)
Duke-Elder.....	Rabbits...	0.15	....	....	0.15	....	....
Ask.....	Rabbits...	0.14	0.14	....	0.14	0.12	....
Ask.....	Young cat	0.15	0.15	....	....	0.13	....
Ask.....	Guinea-pig	0.14	....	....	....	0.12	....
Ask.....	Pig.....	0.09	....	....	....	0.08	....
Cohen et al.....	Pig.....	....	....	0.03	....	....	....
Ask.....	Ox.....	0.06	....	....	....	0.05	....
Cohen et al.....	Ox.....	....	....	0.039	....	....	....
Salit.....	Ox.....	0.086	....	0.055	....	....	0.135
Ask.....	Calves.....	0.08	....	....	....	0.07	....
Salit.....	Calves.....	0.108	....	0.055	....	....	0.145
Ask.....	Sheep.....	0.09	....	....	....	....	....
Cohen et al.....	Horse.....	0.098	....	0.071	....	....	....
Duke-Elder.....	Horse.....	....	....	....	....	0.09	....
Yudkin et al.....	Dogs.....	0.077-0.137	....	....	....	....	....

whole blood, 0.12 per cent. The following figures for primary aqueous and whole blood were obtained by Ask[1] from a single animal in each determination: pig, 0.09 and 0.08 per cent; ox, 0.06 and 0.05 per cent; calf, 0.08 and 0.07 per cent; sheep, 0.09 and 0.08 per cent. The vitreous of pigs' eyes, however, contains only 0.03 per cent sugar and that of oxen 0.039 per cent (Cohen, Killian and Metzger[9]). The sugar values for the aqueous and vitreous and the lens of ox eyes were found by O'Brien and Salit[12] to be 0.086, 0.055 and 0.135 per cent, respectively. In 6 weeks old calves, the corresponding values are: 0.108, 0.058 and 0.145 per cent (Salit). The following values have been obtained on horses: aqueous, 0.098 per cent (Duke-Elder[4]); vitreous, 0.071 per cent (Cohen, Killian and Metzger[9]); serum, 0.091 per cent (Duke-Elder). The sugar contents of the aqueous in two groups of dogs were found by Yudkin, Krause, Goldstein and Berman[13] to be 0.077 and 0.137 per cent.

A summary of the foregoing data on sugar determination is given in table 4.

13. Yudkin, Krause, Goldstein and Berman: Proc. Soc. Exper. Biol. & Med. **24**:451, 1927.

Ask,[1] in his work on rabbits, studied the effect of changes in the sugar level of the blood on the sugar level of the aqueous. The accumulation of sugar in the blood is followed immediately by an increase in the sugar content of the aqueous, in both alimentary and epinephrine hyperglycemia. This is shown in table 5.

The observations of Duke-Elder[4] are in agreement with the data in table 5. Fifteen minutes after an intravenous injection of 10 cc. of a 30 per cent dextrose solution into a rabbit, Duke-Elder obtained 0.204 per cent sugar in the left eye as against 0.146 per cent in the right eye just before the injection. He also found that the sugar content of the aqueous had increased from the normal figure of from 0.152 to 0.175 per cent after the administration of epinephrine to the rabbit.

Man.—For human aqueous and blood from various patients with diseases of the eye, Ask[1] obtained the following average figures: aqueous, 0.10 per cent; plasma, 0.13 per cent; whole blood, 0.098 per cent.

TABLE 5.—*Data on Sugar Level of the Blood and the Aqueous*

	Preformed	First Hour	Second Hour	Third Hour	Fourth Hour	Fifth Hour	After Fifth Hr.
Epinephrine							
Percentage sugar of blood.....	0.12	0.26	0.29	0.27	0.20	0.17	....
Percentage sugar of aqueous....	....	0.14	0.29	0.28	0.37	0.36	0.18
Alimentary							
Percentage sugar of blood.....	0.12	0.23	0.23	0.18	0.15	0.13	....
Percentage sugar of aqueous....	0.15	0.26	0.23	0.22	0.19	0.14	....

PROTEIN

AQUEOUS.—*Animals.*—Rados,[6] employing alcohol as a precipitant, found only a trace (0.017 per cent) of protein in the aqueous of a dog. Examination of the primary aqueous of several horses revealed no protein, except a trace (0.017 per cent) on one occasion. No protein could be demonstrated in the primary aqueous of rabbit eyes. Adler and Landis,[3] however, using the nephelometric method, found in all cases a trace (0.025 per cent) of protein in the aqueous of cats. By dilatation of the capillaries through the application of physostigmine (eserine), the protein was increased on the average by 44 per cent (Adler and Landis). Seidel[14] and Wessely,[2] using a refractometer, likewise found traces of protein in the primary aqueous of cat and rabbit eyes, and Wessely observed also an increase in protein on the induction of hyperemia of the blood vessels of the eye. According to the observations of Duke-Elder,[4] the aqueous of horses' eyes contains 0.02 per cent protein (7.8 mg. of albumin and 12.3 mg. of globulin per hundred cubic centimeters of the eye fluid); that of rabbit eyes, 0.04 per cent. Yudkin,

14. Seidel, E.: Arch. f. Ophth. **95**:1, 1918.

Krause, Goldstein and Berman [13] found an average value of 0.119 per cent protein in the aqueous of dogs' eyes. For cattle eyes, the figure was found by Salit [12] to be 0.019 per cent.

The secondary and tertiary aqueous of animal eyes contains from 0.075 to 3.389 per cent protein in rabbits, from 0.075 to 4.08 per cent in horses, 4.959 per cent in cattle (one determination), and from 0.075 to 2.459 per cent in dogs (Rados [6]). The range of variation in the protein content of secondary aqueous of rabbit eyes is given by Duke-Elder [4] as 1 to 2.5 per cent.

Man.—Rados [6] could detect no protein whatever in human aqueous. Löwenstein,[15] however, speaks of having found "increased" protein values in the aqueous of five patients with iridocyclitis. Likewise Römer [16] produced evidence of "increased" values of protein in the primary aqueous of inflamed eyes.

VITREOUS.—*Animals.*—Cohen, Killian and Metzger [9] found that the vitreous of horses', pigs' and oxen eyes contains 0.022, 0.0393 and 0.0393 per cent protein, respectively. Salit's [12] analysis gave an average of 0.045 per cent protein for the vitreous of ox eyes.

When the vitreous of oxen was allowed to remain in the enucleated eyes for about nine hours and the eyes were kept in an icebox, the protein content of the vitreous was found to have increased from the normal figure of from 0.045 to 1.266 per cent. This was evidently due to transudation from the surrounding capillaries (Salit [12]).

LENS.—*Animals.*—According to Laptschinsky,[17] the normal fresh animal lens contains 34.93 per cent protein. From the work of Bürger and Schlomka [18] on cattle eyes, it is evident that with advancing age there is a constant increase in the protein of the lens. Salit [19] found that the protein increased from 25.86 per cent in 2 months old calves to 35.71 per cent in 2 year old cattle and that the water content diminished proportionately. The lens of an adult sheep contained 23.96 per cent protein (Salit [19]). The lenses of adult rabbits gave an average of 33.4 per cent protein (Salit).

Man.—Cahn [20] stated that the normal dried lens contains about 94.71 per cent protein, whereas cataractous human lenses show a protein content of only 81.48 to 85.37 per cent. Jess [21] has shown that

15. Löwenstein, A.: Klin. Monatsbl. f. Augenheilk. **65**:643, 1920.

16. Römer, P.: Ber. d. deutsch. ophth. Gesellsch. **43**:66, 1920.

17. Laptschinsky: Arch. f. d. ges. Physiol. **13**:631, 1876.

18. Bürger, M., and Schlomka, G.: Ztschr. f. d. ges. exper. Med. **58**:710, 1927.

19. Salit, P. W.: Biochemical Investigation of the Nitrogen, Weight and Water Content of Crystalline Lenses, unpublished.

20. Cahn, A.: Hoppe-Seyler's Ztschr. f. physiol. Chemie **5**:213, 1881.

21. Jess, A.: Ztschr. Biol. **61**:93, 1913.

cataractous lenses are deficient chiefly in crystallines (alpha and beta) as compared with normal lenses and that the ratio of crystallines to albumins in young persons is 82 : 18, whereas in old persons the ratio is 41 : 50. The highest protein values for cataractous human lenses with relatively short durations of the cataract were found by Salit [19] to be 36.63, 35.5, 35.44 and 33.88 per cent. These figures closely agree with

TABLE 6.—*Summary of Data on Protein*

	Aqueous			Vitreous		Lens		
		Per Cent Protein					Per Cent Protein	
Animal	Author	Primary	Secondary and Tertiary	Author	Per Cent Protein	Author	Normal	Cataract
Rabbit	Rados.....	None	0.075-3.389	.....	.....	Salit.....	33.4	.....
	Wessely.....	Trace	.....					
	Duke-Elder...	0.04	1.0-2.5					
Ox	Rados.....	.....	4.959	Cohen et al..	0.0393	Laptschinsky	34.93 (fresh)	.....
				Salit.....	1.266 (vitreous 9 hrs. in extracted eyes)	Salit.....	25.86 (2 mos.) 35.71 (2 yrs.)	.....
	Salit.....	0.019	.....	Salit.....	0.045			
Horse	Rados.....	None to trace	0.075-4.08					
	Cohen et al...	0.022	.....					
	Duke-Elder...	0.024	.....					
Sheep	.....	.....	.....	.....	.....	Salit.....	23.96 (fresh)	.....
Dog	Rados..... ..	0.017	0.075-2.45					
	Yudkin et al..	0.119	.....					
Cat	Adler, Landis	0.025	.....					
Pig	.....	.....	.....	Cohen et al..	0.039			
Man	Rados.....	None	None	.....	.....	Jess.....	32-38	.....
	Löwenstein...	Trace in irido-cyclitis	.....	.....	.....	Salit.....	.....	13.19-36.63
	Römer.....	Trace in inflamed eyes	.....	.....	.....	Cahn.....	94.71 (dried)	81.48-85.37 (dried)

those obtained on the lenses of 2 year old oxen and adult rabbits. On the basis of these facts and the figures for the protein content of normal human lenses, which, according to Jess,[21] are 32 per cent in youth and 38 per cent in old age, it is clear that the normal human lens in its protein content closely resembles that of the adult rabbit and older cattle. The range of variation of the protein content of cataractous human lenses was found to be from 13.19 to 36.63 per cent (Salit [19]).

In table 6 is given a summary of the data discussed under "protein."

LIPIDS

CHOLESTEROL.—*Animals.*—Bürger and Schlomka [20] determined the cholesterol content in the lenses of normal cattle varying in age from 1 day to 17 years. They found that this lipid fraction increased from an average of 0.056 per cent of 1 day to 1 year old cattle to an average of 0.222 per cent for from 14 to 17 year old cattle. Salit [22] who determined the cholesterol content in the lenses of cattle between the ages of 5 weeks and 2 years, found that within this range there was practically no difference in the amount of cholesterol. The analysis gave an average of 0.0433 per cent. The lens from a rabbit contained 0.051 per cent cholesterol (Salit).

Man.—Salit [22] examined two normal human lenses one of which was obtained at autopsy from a 2 year old child and the other from an adult (age unknown). The lenses contained 0.182 and 0.174 per cent cholesterol, respectively. A third lens, obtained from an adult (age unknown) following an accident, contained 0.275 per cent cholesterol. These values are four to five times as high as those for cattle lenses and equal the figures usually obtained on the blood of patients with cataract. According to Cahn,[20] dried normal human lenses were found to contain about 0.62 per cent cholesterol.

Cataractous human lenses have been found to contain abnormally large amounts of cholesterol. According to Cahn's [20] analysis of dried lenses, they showed from 4.559 to 6.22 per cent cholesterol. Salit [22] determined the cholesterol content of twenty-six cataractous human lenses immediately after their extraction. Their average cholesterol content was found to be 0.61 per cent, with a range of variation of from 0.23 to 0.89 per cent.

LECITHIN.—*Animals.*—The lenses of cattle between the ages of 5 weeks and 2 years were found to contain on the average 0.11 per cent lecithin (Salit [22]). The lecithin content is nearly the same for all ages within the foregoing limits. A rabbit lens, the only one examined for lecithin, gave a figure of 0.131 per cent.

Man.—Dried normal human lenses were found by Cahn [18] to contain on the average 0.63 per cent lecithin, whereas the lecithin content of dried cataractous human lenses showed a range of variation of from 0.8 to 4.52 per cent. Cataractous human lenses, analyzed immediately after their extraction, gave an average value of 0.99 per cent, and showed a range of variation of from 0.48 to 1.88 per cent (Salit).

SAPONIFIABLE FAT.—No figures for saponifiable fat in normal crystalline lenses are available. Cataractous human lenses contain on the

22. Salit, P. W.: Chemical Studies of Lipids of Normal Animal Lenses, Cataractous Human Lenses and the Blood of Cataract Patients, unpublished.

average 2.8 per cent saponifiable fat and show a range of variation of from 1.53 to 4 per cent (Salit [22]).

Table 7 gives a summary of the data discussed under "lipids."

CALCIUM

AQUEOUS.—Duke-Elder [4] found 6.2 mg. of calcium per hundred cubic centimeters of the aqueous of horses. According to Salit,[12] the aqueous of ox eyes contains 5 mg. per hundred cubic centimeters.

VITREOUS.—The vitreous of oxen, horses and pigs according to Cohen, Killian and Metzger,[9] contain the following calcium values respectively: 7.9, 8.5 and 7.9 mg. per hundred cubic centimeters of vitreous. Salit [12] found the calcium value for the vitreous of ox eyes to be 7.2 mg. per hundred cubic centimeters.

TABLE 7.—*Summary of Data on Lipids*

Author	Source of Lens	Condition of Lens	Per Cent of Cholesterol	Per Cent of Lecithin	Per Cent of Saponifiable Fat
Bürger and Schlomka	1 day to 1 yr. old cattle	Fresh	0.056	.....	.....
Bürger and Schlomka	14 to 17 yrs. old cattle	Fresh	0.222	.....	.....
Salit.....	5 wks. to 2 yrs. old cattle	Fresh	0.043	0.11	.....
Salit.....	Adult rabbit	Fresh	0.051	0.131	.....
Salit.....	Man	Normal, fresh	0.211	.....	.....
Cahn.....	Man	Normal, dried	0.62	0.63	.....
Cahn.....	Man	Cataractous, dried	4.55-6.22	0.80-4.52	.....
Salit.....	Man	Cataractous, moist	0.23-0.89	0.48-1.88	1.53-4.00

Human ocular humors have not been examined for calcium content.

LENS.—*Animals.*—Bürger and Schlomka [18] demonstrated only a trace of calcium in cattle lenses, using 17 Gm. of the fresh material. Burge,[23] who examined the ash of pigs' lenses, found in it 0.08 per cent calcium (by weight). Eight determinations carried out by Salit [24] on fresh normal ox and rabbit lenses (a single lens being used in each determination) showed no calcium.

Man.—According to Burge, normal human lenses likewise contain no demonstrable amount of calcium. In the ash of human cataractous lenses Burge, however, found 12.5 per cent calcium. Salit,[24] using a single lens in each determination, obtained an average figure of 35.4 mg. per hundred grams of lens material for mature human cataractous lenses. The values varied between 2.8 and 108 mg. per hundred grams. No calcium could be demonstrated in five lenses with incipient cataract. One black cataract, the only one examined, likewise contained

23. Burge: Arch. Ophth. **38**:447, 1909.

24. Salit, P. W.: Calcium Determinations of Cataractous Human Lenses, Am. J. Ophth., to be published.

no calcium. According to the investigations by Adams,[25] the average calcium values of normal and cataractous human lenses are: 18.5 and 65.3 mg. per hundred grams of lens material, respectively.

MAGNESIUM

Magnesium has been determined only on the aqueous of horses. According to Duke-Elder,[4] it amounts to about 2.6 mg. per hundred cubic centimeters of the fluid and approximately equals that of serum (2.8 mg. per hundred cubic centimeters).

UREA

AQUEOUS.—Urea has been determined only on animal eyes. Pagani[26] reported a range of variation from 12 to 95 mg. of urea per hundred

TABLE 8.—*Summary of Data on Calcium*

Author	Source of Material	Aqueous Mg. per Cent Calcium	Vitreous Mg. per Cent Calcium	Lens	
				Per Cent Calcium	Condition of Material
Duke-Elder	Horse	6.5	...	.....	.....
Cohen et al.	Horse	...	8.5	.....	.....
Cohen et al.	Ox	...	7.9	.....	.....
Salit	Ox	5.0	7.2	None	Fresh
Cohen et al.	Ox	...	...	Trace	Fresh
Salit	Rabbit	...	...	None	Fresh
Cohen et al.	Pig	...	7.9	.....	.....
Burge	Pig	...	...	0.08	Ash of normal lens
Burge	Man	...	...	None	Ash of normal lens
Burge	Man	...	...	12.5	Ash of cataractous lens
Salit	Man	...	...	0.003-0.108	Fresh cataractous lens
Adams	Man	...	...	0.019	Fresh normal lens
Adams	Man	...	...	0.653	Fresh cataractous lens

cubic centimeters of the aqueous of calf, lamb and rabbit eyes. Duke-Elder[4] found 28 mg. per hundred cubic centimeters of the aqueous of the horse. According to Yudkin, Krause, Goldstein and Berman,[13] the aqueous of dog eyes contains about 25.7 mg. per hundred cubic centimeters. Salit[12] found the aqueous of ox eyes to contain about 16.7 mg. per hundred cubic centimeters.

VITREOUS.—The urea values of the vitreous of oxen, horses and pigs, as given by Cohen, Killian and Metzger,[9] are 21.1 mg., from 17.1 to 42.8 mg. and 18.8 mg. per hundred cubic centimeters, respectively. Salit[12] obtained 15.25 mg. per hundred cubic centimeters of the vitreous of cattle.

LENS.—Cattle lens contains about 19.8 mg. of urea per hundred grams of lens (Salit[12]).

SERUM.—Horse serum contains 27 mg. of urea per hundred cubic centimeters of the fluid (Duke-Elder[4]).

25. Adams, D. R.: Biochem. J. **23**:902, 1929.
26. Pagani: Biochem. terap. sper. **13**:274, 1926.

A summary of the data on urea is given in table 9.

AMINO-ACIDS

Animals.—The most thorough and extensive investigation of the amino-acids of aqueous was made by Rados.[6] For the rabbit the average figures are: primary, 0.235 per cent; secondary, 0.162 per cent; tertiary, 0.17 per cent; for the horse: primary, 0.037 per cent; secondary, 0.052 per cent; tertiary, 0.04 per cent; for the cow: primary, 0.044 per cent; secondary, 0.06 per cent; for the dog: primary, 0.095 per cent; secondary, 0.101 per cent. Duke-Elder gives the following figures for the horse: primary aqueous, 0.029 per cent; serum, 0.035 per cent. Dogs' aqueous, according to Yudkin and co-workers,[13] contains 9 mg. of amino-acid nitrogen.

TABLE 9.—*Summary of Data on Urea*

Author	Source of Material	Aqueous, Mg. per Cent Urea	Vitreous, Mg. per Cent Urea	Lens, Mg. per Cent Urea	Serum, Mg. per Cent Urea
Pagani	Calf, lamb, rabbit	12-95	....	....	..
Yudkin et al.	Dog	25.7	....	....	..
Duke-Elder	Horse	28	....	....	27
Cohen et al.	Horse	....	21.1	....	..
Cohen et al.	Ox	....	17.1-42.8	....	..
Cohen et al.	Pig	....	18.8	....	..
Salit	Ox	16.7	15.25	19.8	..

TABLE 10.—*Summary of Data on Amino-Acids*

Author	Source of Aqueous	Primary Aqueous, per Cent Amino-Acid	Secondary Aqueous, per Cent Amino-Acid	Tertiary Aqueous, per Cent Amino-Acid	Plasma, per Cent Amino-Acid
Rados	Rabbit	0.235	0.162	0.17	.....
Rados	Cow	0.04	0.06	....	.....
Rados	Horse	0.037	0.052	0.04	.....
Duke-Elder	Horse	0.029	.....	....	0.035
Rados	Dog	0.095	0.101	....	.....
Yudkin et al.	Dog	9 mg. % nitrogen	.....	....	.....
Rados	Man	0.122	0.03	....	.....

Man.—Three determinations made on the primary human aqueous by Rados gave an average value of 0.122 per cent; one determination on the secondary aqueous gave 0.03 per cent.

The data on amino-acids are summarized in table 10.

CREATININE

The creatinine values of the ocular humors of animals have been obtained by various investigators. The values for the aqueous are: cattle, 1.2 mg. of creatinine per hundred cubic centimeters of the eye fluid (Salit[12]); horses, 2 mg. (Duke-Elder[4]); dogs, 1.3 mg. (Yudkin et al.[13]); vitreous: oxen, 1.1 mg. per hundred cubic centimeters of

vitreous (Salit); oxen, 1.1 mg. (Cohen, Killian and Metzger[9]). Plasma of horse serum contains 2 mg. per hundred cubic centimeters of the fluid (Duke-Elder[4]).

CREATINE

Only the vitreous has been examined for creatine. Its amount was found by Cohen, Killian and Metzger[9] to be 1.6 mg. of creatinine per hundred cubic centimeters of the vitreous.

URIC ACID

In the aqueous of dogs uric acid amounts to about 1.9 mg. per hundred cubic centimeters (Yudkin et al.[13]). The vitreous of oxen, horses and pigs contains 2.8 mg., from 1 to 2 mg. and 0.45 mg. of uric acid per hundred cubic centimeters, respectively (Cohen et al.[9]).

LACTIC ACID

Lactic acid has been found in the vitreous of oxen, horses and pigs in the following amounts: 14.8, 17 and 17.5 mg. per hundred cubic centimeters of the vitreous (Cohen et al.[9]).

TOTAL ETHER EXTRACTS

The values on total ether extracts for the aqueous and serum of horses are 4 and 13 mg. per hundred cubic centimeters of the fluids, respectively (Duke-Elder[4]); for the vitreous of the ox, 10 mg. per hundred cubic centimeters (Cohen et al.[9]).

PHOSPHORUS

Duke-Elder[4] examined both the aqueous and serum of horses for inorganic phosphorus and found the values to be 3.3 and 3 mg. per hundred cubic centimeters of the fluids, respectively. Cohen, Killian and Metzger[9] obtained nearly the same figures for total phosphorus of the vitreous of pigs and oxen: pigs, 3.3 mg.; oxen, 2 mg. per hundred cubic centimeters.

SULPHUR

The values of inorganic sulphur in the aqueous and serum of horses are as follows: aqueous, 6.1 mg.; serum, 5.8 mg. per hundred cubic centimeters of the fluids (Duke-Elder[4]). The total sulphur values for the vitreous are: horses, 2 mg.; oxen, 4 mg.; pigs, 4 mg. per hundred cubic centimeters (Cohen et al.[9]).

TOTAL SOLIDS

The aqueous of horses contains 1.086 per cent total solids (Duke-Elder[4]). For vitreous, the values are as follows: horses, 1.06 per cent; oxen, 1.11 per cent; pigs, 1.11 per cent (Cohen et al.[9]). On the basis

that the water content of cattle lenses was found to decrease from 68.6 per cent in 5 week old calves to 64.6 per cent in 2 year old cattle (Salit [19]), it is clear that the solids of the lenses increase accordingly with advancing age.

AUTOXIDIZABLE SUBSTANCES

Arnold and Reis [27] were the first to find that the normal lens gave an intense nitroprusside reaction, showing that it contained cysteine in relatively large amounts. In mature senile cataract the reaction was negative. In nonmature forms the intensity of the reaction varied according to the extent of the cataract formations. Cohen, Kamner and Killian [28] likewise reported having obtained a pronounced nitroprusside color reaction in experiments with normal lenses (human and animal) whereas of sixty-four cataractous lenses twenty-six (40 per cent) showed no color, nineteen presented a trace of color about the periphery, and in nineteen a color definitely lighter than in the normal lens was found. According to Jess,[19] the nucleus of the lens, which consists chiefly of crystallines, is especially rich in cysteine.

It appears that autoxidizable substances, as cysteine and glutathione, must be essential for the lens in carrying on its process of respiration. These substances may be the sole mechanism in the regulation of its gas exchange, since the remoteness of the lens from the blood vessels prevents hemoglobin from being the direct source of oxygen. That some process of oxidation may underlie the metabolism of the lens and that disturbances in this respect may be responsible, at least in part, for cataract formation, is evidenced by the researches of Mashimo.[29] Mashimo found that normal rabbit lenses, when kept submerged in Ringer's solution at a temperature of 30 C., absorbed 60 cm. of oxygen per hour, whereas cataractous lenses took up 3 to 25 cm. Schmerl [30] obtained less striking results with rabbit lenses, recording an oxygen absorption of only 4 cm. per hour at 37.7 C. When naphthalene was fed to the rabbits and five hours later the lenses were examined for oxygen, they had taken up 7 to 20 cm. per hour.

HYDROGEN ION CONCENTRATION

Aqueous.—*Animals.*—(The work on ocular humors was carried out by Salit [31]). The hydrogen ion concentration of the aqueous in the eyes of cattle between the ages of 5 weeks and 2 years was found to decrease as follows: 5 weeks, p_H 7.23; 2 months, p_H 7.22; 4 months,

27. Arnold and Reis: Arch. f. Ophth. **80**:588, 1912.

28. Cohen, Kamner and Killian: Proc. Soc. Exper. Biol. & Med. **25**:677, 1928.

29. Mashimo, M.: Klin. Wchnschr. **39**:1809, 1923.

30. Schmerl: Arch. f. Ophth. **119**:130, 1927.

31. Salit, P. W.: A Study of the Acid-Base Equilibrium of the Ocular Humors, Biochem. J. **24**:596, 1930.

p_H 7.32; 8 months, p_H 7.39; 1½ years, p_H 7.40; 2 years, p_H 7.40. (Hydrogen ion concentration is inversely proportional to p_H.)

Man.—The p_H values of normal human aqueous, according to Baurmann,[32] lie between 7.20 and 7.35. Only a few values are below 7.30. The average is 7.27. No difference in p_H was observed between human primary and secondary aqueous (the reformed aqueous of rabbit eyes grew successively more acid). The p_H of the aqueous of patients with glaucoma agreed with that of normal persons.

VITREOUS.—*Animals.*—The vitreous likewise becomes more alkaline with increasing age, thus: 3 months, p_H 7.29; 4 months, p_H 7.40; 8 months, p_H 7.40; 1½ years, p_H 7.43; 2 years, p_H 7.50.

When both the aqueous and vitreous were allowed to remain in the enucleated eye for several hours, they became more acid in spite of a possible loss of carbon dioxide. This may be due to infiltration of autolytic decomposition products. Thus fresh aqueous of 1½ and of

TABLE 11.—*Comparison of p_H Values of the Aqueous and Vitreous*

Aqueous		Vitreous	
Age	p_H	Age	p_H
5 weeks	7.23		
2 months	7.22	3 months	7.39
4 months	7.32	4 months	7.40
8 months	7.39	8 months	7.40
1½ years	7.40	1½ years	7.43
2 years	7.40	2 years	7.50

2 year old animals had p_H values of 7.41 and 7.40, respectively; the p_H values of the aqueous of preserved eyes of the same ages, on the other hand, were 7.29 and 7.23, respectively. The p_H values of the vitreous of 1½ year old animals were: fresh, 7.44; preserved, 7.27; the p_H values of the vitreous of 2 year old animals were: fresh, 7.51; preserved, 7.39.

A comparison of the p_H values of the aqueous and vitreous, as given in table 11, shows that the aqueous is slightly but consistently less alkaline than the vitreous.

The p_H figures (from 7.20 to 7.35) of human aqueous are definitely lower than those for human plasma (from 7.35 to 7.50). The data on the ocular humors of ox eyes show, on the whole, smaller differences between the aqueous and the vitreous than Baurmann observed between the plasma and aqueous in man. It is clear that the order of increasing values of the hydrogen ion concentration (or decreasing alkalinity) on the p_H scale is represented by the ocular humors and the plasma as follows: p_H of plasma > p_H of vitreous > p_H of aqueous.

32. Baurmann, M.: Arch. f. Ophth. **118**:369, 1927.

CARBON DIOXIDE

AQUEOUS.—*Animals.*—The carbon dioxide content of the aqueous exceeds that of whole blood, both arterial and venous, as well as that of arterial plasma, but equals the carbon dioxide content of venous plasma (Kronfeld [5]). This is shown in table 12.

The fact that the aqueous and plasma agree closely with respect to their carbon dioxide content is in accordance with the observations of Warburg [33] on the various components of horse blood. He has shown that the serum, especially its water phase, the ultrafiltrate, contains considerably more carbon dioxide than the whole blood. This indicates that the carbon dioxide must be chiefly bound with substances that are diffusible through the membrane. Kronfeld [5] also showed that the bicarbonate values of the aqueous fluctuate with those of the whole organism. One group of rabbits was fed a diet rich in alkali (bread and greens); another group of rabbits was fed a diet deficient in alkali

TABLE 12.—*Data on Carbon Dioxide Content*

Animal	Whole Blood Carbon Dioxide, per Cent by Volume		Plasma Carbon Dioxide, per Cent by Volume		Aqueous Carbon Dioxide, per Cent by Volume
	Arterial	Venous	Arterial	Venous	
Dog	48.0	55.4	64.4	70.0	69.0
Rabbit	35.1	42.4	49.8	56.3	58.2
Horse	....	56.6	....	67.4	66.8

(oats and hay). The average results of the two groups of rabbits respectively are: ocular tension, 24 and 23.3; alkali reserve of the venous blood, 42 and 35.7; carbon dioxide content of the aqueous, 55.4 and 50.3. When 100 cc. of 5 per cent sodium bicarbonate was injected into the femoral vein of a dog, the peak of the increase in the alkali reserve of the blood preceded that of the aqueous.

The carbon dioxide content of the aqueous of 1½ to 2 year old cattle was found to be 47.5 per cent by volume (Salit [31]).

The experiments of Kronfeld [5] on the aqueous of horses show that it takes up little additional carbon dioxide on being subjected to higher carbon dioxide tensions. The amount that is absorbed under an increased carbon dioxide tension exactly corresponds to the solubility coefficient of carbon dioxide in pure water.

Man.—Kronfeld [5] determined the carbon dioxide content of the aqueous and venous blood in man. For eyes normal in respect to both tension and anterior bulbus the average figures are: aqueous, 66.55 per cent by volume; blood, 50.38 per cent by volume; for primary glaucoma without inflammation: aqueous, 66.55 per cent by

33. Warburg: Biochem. J. **16**:163, 1922.

volume; blood, 54.07 per cent by volume; for inflamed eyes; aqueous, 73.9 per cent by volume; blood, 55.53 per cent by volume.

VITREOUS.—Only the vitreous has been studied with respect to the relationship between its carbon dioxide content and age (Salit [31]). The carbon dioxide content of the vitreous of cattle decreases with increasing age. The results are shown in table 13.

The carbon dioxide content and capacity of the vitreous are alike. The determination of the carbon dioxide capacity differed from the determination of carbon dioxide content in that the former sample was equilibrated with alveolar air before the carbon dioxide was withdrawn. Under these conditions the vitreous took up no additional carbon dioxide.

TABLE 13.—*Relationship Between Carbon Dioxide Content and Age*

Age	6 Wks.	2 Mos.	3 Mos.	4 Mos.	8 Mos.	1 Yr.	1½ Yrs.	2 Yrs.
Carbon dioxide, per cent by volume	58.7	74.2	60.5	52.3	59.7	59.0	44.4	42.9

TABLE 14.—*Data on Dissociated Diffusible Substances*

	Aqueous		Serum	
Cations	Per Cent	Millimols per Liter	Per Cent	Millimols per Liter
Na^+	0.278	121.2	0.3351	145.6
K^+	0.0189	4.8	0.0201	5.1
Ca^{++}	0.0062	1.5	0.0101	2.5
Anions				
Cl^-	0.4371	123.1	0.3664	103.2
PO_4^{---}	0.0044	1.38	0.0040	1.26
SO_4^{--}	0.0061	1.8	0.0058	1.7

From the foregoing data it is evident that the carbon dioxide content of the aqueous (47.5 per cent by volume) exceeds that of the vitreous (43.7 per cent by volume) in 1½ to 2 year old animals by about 3.8 per cent by volume.

DISSOCIATED DIFFUSIBLE SUBSTANCES

The dissociated diffusible substances are unequally distributed between serum and aqueous. This is shown in table 14 (Duke-Elder [4]).

Rona and György [34] found that from 15 to 28 per cent of the total quantity of sodium in the blood was associated with protein and rendered indiffusible for this reason. Rona and Takahashi [35] found that from 30 to 40 per cent of the total calcium of the blood was similarly bound with protein. Conversely, the acid radicals show a predominance

34. Rona and György: Biochem. Ztschr. **56**:416, 1913.
35. Rona and Takahashi: Biochem. Ztschr. **49**:370, 1913.

in the aqueous, the chloride ions showing a higher relative concentration than the phosphate and sulphate ions which are being held back to some extent in loose combination with the protein (Duke-Elder [4]). It is evident from table 14 that the relative distribution of anions and cations between the aqueous and plasma is regulated by the Donnan equilibrium. In the Donnan equilibrium, the product of the concentrations of a pair of diffusible cations and anions must be equal on both sides of the membrane, thus: $(Na^+)_{aqueous} \times (Cl^-)_{aqueous} = (Na^+)_{serum} \times (Cl^-)_{serum}$. By substituting numerical values from table 14: $121 \times 123 = 145 \times 103$, or $148.3 = 149.35$, which agrees well with the theory within experimental error.

COMMENT

Biochemical studies of the aqueous, lens and vitreous center around two common eye diseases—glaucoma and cataract. Among other suggested causes of glaucoma, changes in the hydrogen ion concentration of the blood and the ocular humors have been considered. It is a well known fact in biochemistry that the water absorbing ability or turgescence of a protein depends on the hydrogen ion concentration of the aqueous medium surrounding it. By plotting a swelling curve of a protein under different hydrogen ion concentrations, one notes two points of special interest. These are the minimum and maximum swellings or the smallest and greatest volumes occupied by the protein. It has been shown that changes in the hydrogen ion concentration of the blood take place under certain pathologic conditions. Thus in diabetes, eclampsia and hyperpituitarism, the reaction of the blood is shifted toward the acid side. In these diseases a lowered intra-ocular pressure has been observed (Imre,[36] Hasselbach and Gammeltoft [37]). Furthermore, Hertel [38] found the aqueous of patients with glaucoma slightly more alkaline than the aqueous of eyes with normal tension. This suggests the possibility that in glaucoma the reaction of the vitreous also is shifted from the normal p_H farther to the alkaline side, thus causing the protein of the vitreous to absorb more water. When such a change occurs in the reaction of the vitreous it must come from the blood. In fact, Meesmann [39] reported having observed an increased alkalinity of the blood in patients with glaucoma. Fradkin, Krasnowa and Cheifez,[40] however, found a normal reaction of the blood of patients with glaucoma. They likewise could produce no glaucoma by experimental

36. Imre, J., Jr.: Arch. f. Augenheilk. **88**:155, 1921.

37. Hasselbach and Gammeltoft: Biochem. Ztschr. **68**:206, 1915.

38. Hertel: 42. Vers. d. Heidelberger Ophthalm. Ges. 1920, p. 73.

39. Meesmann, quoted by Fradkin, Krasnowa and Cheifez: Zentralbl. f. d. ges. Ophth. **23**:70, 1930.

40. Fradkin, Krasnowa and Cheifez: Zentralbl. f. d. ges. Ophth. **23**:70, 1930.

alkalosis. Moreover, Baurmann,[32] who studied the reaction of both normal and glaucomatous eyes in man, observed no differences in the hydrogen ion concentrations of the aqueous. These contradictory results may be due to one or more of the following reasons: 1. There may be lack of appropriate methods for measuring small changes in the hydrogen ion concentration of the blood and the ocular humors. 2. A multiplicity of causes may produce the abnormal intra-ocular pressure. Some of these possible causes are: blocking of Schlemm's canal (Seidel[41]); general edema or increased permeability of the capillaries, as in patients with beriberi (Heimann[42]), increased tonus of the arterioles (Gager,[43] Espildora Luque[44]); hemorrhage into the retina, associated with arteriosclerosis (Gager[43]). 3. There may be changes or inherent differences in the nature and amount of buffers, especially protein, in different subjects and different parts of the body combined with the differences in the time it takes for a buffer to counteract a change in the hydrogen ion concentration. 4. Changes in the relative concentrations of salts may take place in the blood and the ocular humors. Experiments with gelatin have shown that osmotic pressure, viscosity and swelling are decreased by the presence of salts (Loeb[45]). The depressing effect is in turn increased by the concentration of the salts, polyvalent ions being more effective than monovalent ions.

From the foregoing facts it is evident that in order to study glaucoma from the biochemical standpoint, knowledge of the acid base equilibrium must be supplemented by a thorough knowledge of all the chemical constituents of the ocular humors in their relationship to those of blood and spinal fluid. The importance of this suggestion is brought out in the experiments by Lambert and Wolff.[46] By intravenous injections of from 200 to 300 cc. of a 5 per cent sodium chloride solution, they reduced temporarily the intra-ocular pressure in ten patients with glaucoma to the extent of from 7 to 17 mm. of mercury, due in all probability to shifting of the osmotic pressure. In this connection it is essential also to study the physical and physiologic properties of the membranes between systems of body fluids. The data covered by the foregoing review show that the fluids of different parts of the body may differ in their hydrogen ion concentrations, thus p_H of plasma $>$ p_H of vitreous $>$ p_H of aqueous. These differences in p_H can be explained

41. Seidel, E.: Arch. f. Ophth. **102**:415, 1920.

42. Heimann: Ztschr. f. Augenheilk. **71**:82, 1930.

43. Gager, L. T.: Hypersensitive Retinal Disease, Arch. Ophth. **2**:307 (Sept.) 1929.

44. Espildora Luque, C.: Zentralbl. f. d. ges. Ophth. **22**:421, 1929.

45. Loeb: Proteins and the Theory of Colloidal Behavior, New York, McGraw-Hill Book Company, p. 162.

46. Lambert, Robert K., and Wolff, Julius: Arch. Ophth. **2**:198 (Aug.) 1929.

on the basis of different degrees of permeability of the intervening membranes to blood proteins. It is seen from table 14 that the protein-rich serum, in comparison with the ocular humors, contains a considerable excess of basic radicals, especially sodium and calcium, whereas aqueous surpasses serum in acid radicals.

The data reviewed show further that the hydrogen ion concentration of both the aqueous and vitreous decreases with advancing age. This is true also with respect to the carbon dioxide content. It is to be regretted that no such work has been done on human ocular humors. It is possible that the deposition of abnormally large amounts of calcium in cataract lenses is brought about by a process suggested by Parsons [47] for the deposition of calcium in bone. According to this author, the diffusible calcium of the blood, on account of the high carbon dioxide content of the blood, exists in the form of ions of dicalcium phosphate and calcium bicarbonate. When these ions arrive at the osteoid and diffuse into the interstitial spaces, where the concentration of carbon dioxide is below the plasma level, calcium is precipitated in the form of tricalcium phosphate. The following equation illustrates the reaction:

$$\underbrace{(Ca^{++})^2 + (HPO^{=}_4)^2}_{\text{Dicalcium phosphate ions}} + \underbrace{(Ca^{++}) + (HCO_3^-)^2}_{\text{Calcium bicarbonate ions}} \rightleftarrows 2\,CaHPO_4 + Ca(HCO_3)_2 \rightleftarrows$$

$$Ca_3(PO_4)_2 + 2\,H_2CO_3$$

in the bone

If the carbon dioxide tension of this solution be reduced, the reaction will procede to the right and calcium phosphate will be deposited.

Quite in agreement with the foregoing theory, Levina and Chejfetz [48] reported having found the carbon dioxide content of the blood of patients with cataract greatly reduced, from 26.5 to 57.4 cc. carbon dioxide per hundred cubic centimeters of serum. If this condition be an uncompensated alkalosis, the foregoing theory is further corroborated by the fact that about 88 per cent of cases of senile cataract are associated with latent tetany (Fischer and Triebenstein [49]). Examinations of blood of patients with tetany reveal a shift of the p_H to the alkaline side and a decrease in the ionized calcium (Duke-Elder [50]).

The data on chlorides suggest an inverse relationship between the amounts of chloride ions and protein (see tables 1 and 2). Thus the chloride values (expressed as sodium chloride) diminish inversely to the amount of protein. For rabbits the figures are: primary aqueous,

47. Parsons, L. G.: Lancet **2**:433, 1928.

48. Levina and Chejfetz: Zentralbl. f. d. ges. Ophth. **22**:121, 1929.

49. Fischer and Triebenstein, O.: Klin. Monatsbl. f. Augenheilk. **27**:441, 1914.

50. Duke-Elder, W. S.: The Nature of the Intra-Ocular Fluids: Being the Sir Francis Laking Prize, 1926-1927. Brit. J. Ophth., monograph supplement III, pp. 140. London, George Pulman and Sons.

0.630 per cent; reformed aqueous, from 0.558 to 0.591 per cent; serum, from 0.551 to 0.590 per cent (table 1); for cattle: primary aqueous, 0.702 per cent; vitreous, 0.680 per cent; secondary aqueous, 0.644 per cent, lens, from 0.187 to 0.340 per cent (table 2). This agrees with the facts brought out in the discussion of dissociated diffusible substances.

The following substances, which Duke-Elder [4] determined on both the aqueous and serum of horses, seem to be distributed more or less equally between the aqueous and the blood: nonprotein nitrogen, urea, creatinine, amino-acids, inorganic sulphur and inorganic phosphorus.

There are distinct differences in the sugar contents of the aqueous of certain different species of animals. Thus in both rabbits and guinea-pigs the average value is 0.14 per cent; the values for pigs, oxen and sheep vary between 0.06 and 0.09 per cent (Ask [1]).

The sugar contents of blood, ocular humors and lens, in order of ascending values, are represented as follows: vitreous, whole blood, aqueous, plasma, lens.

The lipid content of senile human cataracts is abnormally high. There is also evidence that blood cholesterol of patients with cataract is slightly above normal (O'Brien and Myers [51]). Michail and Vancea [52] produced hypercholesterolemia in rabbits by feeding them naphthalene. They ascribed this condition to the reaction of the organism in combating the naphthalene poisoning. It is possible that the accumulation of lipids in cataractous lenses is the consequence of a similar physiologic reaction toward certain poisons in the blood.

From the data published by Rados,[6] it appears that the human eye has a much finer and denser structure than the eye of any other mammal thus far studied. In all animal eyes, there is a large increase in the protein content of the aqueous following punctures (Rados, Duke-Elder), equal in some cases to one half of that of serum. In man, however, the reformed aqueous is said not to differ in its protein content from the primary aqueous. On this basis, Elschnig [53] assumed the aqueous in animals to be a transudate from the blood, whereas the aqueous in man he regarded as a secretory product of the ciliary body.

51. O'Brien, C. S., and Myers, V. C.: Chemical Analysis of Blood in Patients Having Senile Cataract, Arch. Int. Med. **42**:376 (Sept.) 1928.

52. Michail, D., and Vancea, P.: Compt. rend. Soc. de biol. **97**:1569, 1927.

53. Elschnig, A.: Ber. d. deutsch. ophth. Gesellsch. **42**:65, 1920.

News and Notes

PERSONAL NEWS

At the recent meeting of the American Medical Association in Detroit, the Ophthalmic Research Medal was awarded to Dr. Frederick H. Verhoeff of Boston.

Dr. Conrad Berens of New York was elected chairman of the Section on Eye, Ear, Nose and Throat of the New York State Medical Society at its June meeting in Rochester.

Dr. J. O. McReynolds of Dallas has been elected president of the State Medical Association of Texas.

UNIVERSITY NEWS

The medical department of the Western Reserve University has recently promoted Dr. A. B. Bruner to be associate clinical professor of ophthalmology, and Dr. M. Paul Motto to be senior instructor in ophthalmology.

A committee of the Chicago Ophthalmological Society under the chairmanship of Dr. Harry Gradle is organizing a postgraduate course in ophthalmology for ophthalmic residents in the various Chicago hospitals.

CORRECTION

Professor Fuchs has noted the following errors in the translation of his paper, "Localization of Pathologic Changes in the Cornea" (ARCH. OPHTH. **3**:588 [May] 1930): On page 589, fifth column and fifth line of table, "trachomatosa" should read "trachomatous"; on page 590, third line, "normal" should read "abnormal"; on page 593, fourth line from the bottom, "Then" should be "These," and in last line, "are numerous" should read "are more numerous"; on page 594, ninth line, "adjoining vessels" should read "adjoining the vessels," in tenth line, "corneal tissue, contain" should read "corneal tissue contains," and twelfth line from the bottom, "inflammation at a later date that antibodies" should read "inflammation that at a later date antibodies"; on page 595, fifteenth line "[Groenouw grill-formed]" should read "[Groenouw] grill-formed."

Obituary

JAMES M. PATTON, M.D.

1876-1930

Dr. James M. Patton, of Omaha, professor of ophthalmology in the University of Nebraska Medical College, died suddenly of angina pectoris at his home on June 20, 1930.

Dr. Patton was associated with the late Dr. Harold Gifford for twenty years, until Dr. Gifford's death, and was long recognized as one of the leaders in ophthalmology in the Middle West. He was born in Mercersburg, Pa., in 1876, and graduated in medicine from the University of Nebraska Medical College in 1904. After Dr. Gifford's retirement from university work in 1928, he succeeded him in the chair of ophthalmology. A tireless worker, he became an excellent ophthalmic surgeon, and carried on a large practice with great success. He served as a major in the Medical Corps during the World War, being in charge of the large ophthalmologic center at Vitelle.

He wrote numerous articles for the ophthalmologic journals, most of these being of a practical nature. Some described instruments, such as his fixation forceps and his forceps and rings for applying markers for roentgenograms of the globe. Several were devoted to the protection of working men from injuries of the eye, and one to foreign protein therapy. He was especially interested in the care of the blind, and was one of the first to attempt organized education for the adult blind in Nebraska. He was a member of the American Academy of Ophthalmology and Oto-Laryngology, the American Ophthalmological Society, his local ophthalmological society, and the Section on Ophthalmology of the American Medical Association, for which he served as vice chairman in 1924. His work on the American Board for Ophthalmic Examinations was highly valued. In 1921, he served as president of the Omaha-Douglas County Medical Society.

Dr. Patton had few personal hobbies except his professional, civic and church work, which kept him constantly interested. He enjoyed especially his teaching of undergraduates, to which he devoted much time and thought, and his personal relationship with interns and students. He was quiet and unassuming, with a kindness and willingness to make personal sacrifices which endeared him to his patients, students and associates. By his death at the age of 53, the medical profession of Nebraska has suffered a serious loss. He leaves a widow and a son, John Patton.

S. R. GIFFORD.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Comparative Ophthalmology

THE FUNDUS OCULI OF THE DOG. E. LEONARDI, Ann. di ottal. e clin. ocul. **58:** 18 (Jan.) 1930.

The author examined the fundus of 100 dogs of different species and photographed typical examples with the Gullstrand ophthalmoscope adapted for this purpose.

A peculiarity of the canine fundus is the tapetum lucidum, which varies greatly from green to blue or orange in the dog of the same species. This color is due to the varying optical diffraction in a syncytium of fibers and not to pigment. It has no relation to the color of the hair or the iris.

In two large animals a coloboma of the tapetum lucidum was seen and in another with aniridia, there was a complete absence of the tapetum. This indicated a lack of development in the fibers in the first five to six weeks of life. In three fourths of the animals the nerve was only half surrounded by the tapetum. Many interesting variations were seen in the arrangement of the vessels. The large arteries and veins were often enclosed in a single sheath, so as to appear like one vessel. A circle of veins was commonly seen on the disk, which showed peculiar pulsating variations in caliber.

S. R. GIFFORD.

Congenital Anomalies

CONUS TEMPORALIS INVERSUS. W. LOHMANN, Arch. f. Augenh. **100-101:** 853, 1929.

The author describes two cases in which the optic papilla showed a dehiscence on the temporal side just inside the choroidal crescent. He discusses the origin of these as a developmental tendency ("Entwicklungs Tendenzen"), the importance of which he has stressed in the origin of myopia.

F. H. ADLER.

Cornea and Sclera

A CASE OF BUPHTHALMIA WITH NORMAL UNAIDED VISION. J. H. DOGGART, Brit. J. Ophth. **14:**229 (May) 1930.

A boy, aged 10 years, had corneas measuring 13.5 mm. in diameter. Vision in each eye unaided equaled 6/6, and ability to read Jaeger's test type no. 1. In every other respect the eyes were normal, except for an anomaly of the central artery of the retina in the right eye. The central artery was invisible, but six arterial branches radiated from the edge of the disk. The paternal uncle of the patient's mother has a son whose four children were all said to have very large corneas.

The author discusses the classification of such cases. He points out that Kayser, Seefelder and Collins believe that they should be considered as megalocornea, but he prefers to designate them as buphthalmia, because he thinks it improbable that there is any sharp line of division between the two conditions.

W. ZENTMAYER.

MARGINAL SYMMETRICAL DYSTROPHY OF BOTH CORNEAS WITH BILATERAL SPONTANEOUS PROLAPSE OF THE IRIS. A. J. MANES and H. B. MOULIÉ, Arch. de oftal. de Buenos Aires **5:** 5 (Jan.) 1930.

A case of marginal symmetrical dystrophy of both corneas with bilateral prolapse of the iris is reported. This rare disease was first described by Terrien in 1900. The authors consider the process as degenerative and noninflammatory. C. E. FINLAY.

Experimental Pathology

PHLYCTENULAR KERATOCONJUNCTIVITIS AND ALLERGY. G. LODDONI, Ann. di ottal. e clin. ocul. **58:** 28 (Jan.) 1930.

The author gives a review of the literature, including the experimental production of phlyctenules by tuberculin, horse serum and other proteins. He found the tuberculin test to be nearly always positive in these cases. Several cases are reported in which repeated intradermal tests caused the appearance of new phlyctenules. In one case the phlyctenules developed during convalescence from measles but a von Pirquet reaction was positive. One patient with a negative von Pirquet reaction later developed symptoms of pulmonary tuberculosis; later the von Pirquet reaction was positive. The same change from a negative to a positive von Pirquet was seen in another case, this observation being interpreted by the author as a change from a stage of anergy to one of hyperallergy in a tuberculous patient. Sixteen patients were tested by tuberculin and various other proteins. Most of them were positive to tuberculin and a number to horse serum, but very few to the other substances.

Rabbits given subcutaneous injections of horse serum and then tuberculin subconjunctivally developed phlyctenules; the same occurred when the procedure was reversed. It did not occur when other substances, such as a nonspecific milk preparation and gonococcus vaccine, were used.

The author concludes that although in most cases tuberculosis is present elsewhere in the body and is usually the cause of phlyctenulosis, some cases are undoubtedly free from tuberculosis and the phlyctenules are produced by some other agent. Such a process is seen in cases of blepharitis. From the number of patients reacting positively to horse serum as well as to tuberculin, it seems that an allergy to tuberculin is often accompanied by allergy to horse serum. S. R. GIFFORD.

HYPERTONUS AND COMPENSATORY HYPOTONUS IN THE EYE. K. VON HOFE, Arch f. Augenh. **102:** 315, 1930.

The author objects to the conclusions drawn by Seidel from the results of his fluorescein test in trephined glaucomatous eyes. On the basis of these experiments, Seidel maintained that one could draw certain conclusions regarding normal physiologic processes. The author carried out a series of experiments in which from 0.1 to 0.2 cc. of physiologic solution of sodium chloride was injected into the vitreous of a rabbit's eye. The intra-ocular pressure of each eye was measured with a tonometer over a considerable period of time. The tables and graphs

show that following the injection there was a considerable increase in the pressure of the experimental eye followed by a fall in the pressure below normal. This fall persisted for some days. The graphs also indicate that some slight changes occur in the control eye. From these experiments the author concludes that even as simple a procedure as an injection of sodium chloride upsets the physiologic scheme of things so that one should draw no such conclusions as Seidel has done from eyes on which a trephine operation has been performed. He explains the hypertonus and compensatory hypotonus of vascular reactions to changes in internal pressure in the globe.

F. H. ADLER.

EXPERIMENTAL AND HISTOPATHOLOGIC NOTES ON THE INFLUENCE OF A SINGLE IRRADIATION WITH BUCKY'S RAYS ON THE HEALTHY EYE. I. KRASSO, Ztschr. f. Augenh. **70:** 237 (Feb.) 1930.

In 1926, Bucky introduced an irradiation of the superficial layers of the skin by light waves which he found lying between the ultraviolet group and those of the roentgen rays. These rays are electromagnetic oscillations, having a wave length of from 1 to 4 Angström units and produced by a special electron tube having a water-cooled anode. The tube is protected with a Lindemann window, which is made of glass having a low atomic weight. The apparatus can be attached to any alternating current of 200 volts. The tension necessary for the production of these rays is between 8 and 12 kilowatts. The rays which are disseminated into the surrounding atmosphere are not harmful to the observer, for they are readily absorbed by the air.

Krasso observed that a reaction of the conjunctiva of the rabbit's eye after the use of these so-called grenz rays was in the nature of a weak erythema of the conjunctiva which disappeared gradually from the tissue and left no permanent injury. With a dose approximating 980 R units, the cornea showed a transitory epithelial damage which regenerated completely later. With a dose of 3,360 R units, the substantia propia showed a reaction in its upper third.

It was found that the epithelium absorbed more of the grenz rays than it did of the roentgen rays. The reaction in the tissue depends not only on the amount of absorbed energy but also on the quantity of the exposure. The roentgen rays seem to penetrate into the deeper layers, whereas the grenz rays affect only the superficial parts. The author shows that a dosage of from 890 to 980 R units of roentgen rays produces cataracts and inflammation of the tissue of the iris, whereas equivalent units of the grenz rays give merely superficial disturbances. In this paper Krasso explains the unit system and the method of application in detail.

A. M. YUDKIN.

General Diseases

POST-TRAUMATIC OCULAR TUBERCULOSIS. N. M. BLACK and H. HAESSLER, Am. J. Ophth. **13:** 139 (Feb.) 1930.

Two cases are described. The first occurred after a combined extraction in a woman, aged 70, with pulmonary tuberculosis. The cornea was opaque and vascularized in the upper quadrant, and there

were numerous unpigmented postcorneal deposits varying from the finest granules to large lardlike masses. The iris was firmly bound down to a pseudomembrane of plastic exudate which filled the pupil. Throughout the iris stroma were nine pearly gray, translucent, protruding masses, chiefly peripherally placed. Three years later the eye was quiet, the posterior surface of the cornea was practically free from deposits and the lesions interpreted as tubercles had begun to retrogress and be replaced by atrophic spots in the iris. In case 2, a child, aged 10, was struck in the eye with a piece of ice. Two months later he entered the hospital with a bilateral uveitis and partial cataract. Each iris was swollen, and there were many synechiae and a thick plastic exudate in the pupil, as well as numerous thick unpigmented postcorneal deposits. No systemic tuberculosis could be found. The eyes grew steadily worse, and one year after injury sharply defined grayish swellings were seen in the iris.

W. S. REESE.

Glaucoma

A CASE OF BILATERAL BUPHTHALMIA WITH MULTIPLE CONGENITAL ABNORMALITIES IN ONE EYE. G. G. PENMAN, Brit. J. Ophth. **14**:232 (May) 1930.

Buphthalmia of an advanced degree was present in both eyes of a boy, aged 6 years, who suffered intensely from photophobia. In the left eye besides there was almost complete aniridia. There was a rim of rudimentary iris, which at 11 o'clock was wider, from the anterior surface of which a strip of white anterior vascular sheath remnant, with some vessels on its surface, ran to the center of the anterior surface of the lens. The edge of the lens below presented a double coloboma, the suspensory ligament being absent in that region.

Both eyes were trephined. The tension was greatly improved thereby in the right eye but no change was effected in the left. The author attributes the photophobia to the aniridia in the left eye.

W. ZENTMAYER.

GLAUCOMA. G. CIRINCIONE, Ann. di ottal. e clin. ocul. **58**: (Jan.); 99 (Feb.) 1930.

This is part of a text of ophthalmology begun by the late Prof. G. Cirincione, which the *Annali di ottalmologia e clinica oculistica* is printing serially.

The distinction between glaucoma and cataract was first proposed by Brisseaud in 1709, after dissection of the eyes of Bourdelot, the physician of Louis XIV, who was blind from glaucoma, and who willed his eyes for dissection. The lens was found clear, but on account of some opacities in the vitreous Brisseaud considered this the site of glaucoma.

The author describes the types of glaucoma, with their symptoms, diagnosis and differential diagnosis.

In the second part the pathologic anatomy and causes of glaucoma are taken up.

S. R. GIFFORD.

Lens

CLINICAL EXPERIENCES IN THE OPERATIVE TREATMENT OF CONGENITAL CATARACT. D. KLARE, Arch. f. Augenh. **102:** 165 (Dec.) 1929.

This is a monographic treatment of congenital cataracts as observed in the ophthalmological clinic of Jena University during the last ten years. All forms of cataract other than traumatic are dealt with. The author found that in 74 per cent of the cases in which operations were performed useful vision was obtained. Without operation 57 per cent of the patients could not be accepted in the normal school. Serious complications were found in only 2 of 106 eyes on which operations were performed: 1 detachment of the retina and 1 phthisis bulbi. There was no loss of any eye through infection. The value of various methods of operation is described.

F. H. ADLER.

INSTRUMENT FOR CUTTING MEMBRANE IN SECONDARY CATARACT. G. LEVINSOHN, Arch. f. Augenh. **102:** 387 (Dec.) 1929.

The author describes once more a curved knife needle for the cutting through of capsular remains. He describes the advantages of this instrument and records a case showing its effectiveness.

F. H. ADLER.

Neurology

COMPRESSION OF THE HEAD CAUSING TEMPORARY SIXTH NERVE PARALYSIS. C. G. SCHURR, Brit. J. Ophth. **14:**231 (May) 1930.

A girl, aged 4 years, suffered a compression of the head between the occiput and the chin in an elevator shaft. The face was swollen "black and blue." After regaining consciousness at the end of twenty-four hours, the left eye was turned in. There was an isolated palsy of the sixth nerve. The fundus was normal. Five months later, outward rotation was restored but the eye was still rotated inward. The author believes that the external rectus was stretched during the period of paralysis and that the use of a suture fixing the eye in outward rotation would have prevented this.

W. ZENTMAYER.

EYE SYNDROMES IN ENCEPHALITIS RESEMBLING THOSE IN EXOPHTHALMIC GOITER. K. VELHAGEN, JR., Klin. Monatsbl. f. Augenh. **84:** 189 (Feb.) 1930.

The phenomena of Graefe, Dalrymple, Moebius and Stelwag, frequently found in exophthalmic goiter, are not idiomatic of it. The author found them, respectively, in four cases of encephalitis. They may be present occasionally in hysteria, but never in cerebral tumors. Velhagen, therefore, considers the phenomena mentioned as syndromes valuable for differential diagnosis. He discusses the question as to whether in exophthalmic goiter they are caused by a toxic lesion in the vicinity of the third ventricle and of the Sylvian aqueduct or by one of the motor stem ganglions. His hypothesis seems to be supported by the appearance of these symptoms in epidemic encephalitis, which is known to produce severe lesions in these regions; also by the fact that both encephalitis and exophthalmic goiter may be accompanied by a number of other symptoms common to both, and lastly by anatomic factors observed in both of them.

K. L. STOLL.

Orbit, Eyeball and Accessory Sinuses

FRACTURE OF THE ORBIT AND EXOPHTHALMOS. PUSCARIU, Cluj. med., 1929, no. 9.

A woman, aged 61, had had exophthalmos for several years. The globe was turned downward and inward. No symptoms appeared on digital palpation and there were no inflammatory ones. Diplopia was present. The eyeground was normal. The Wassermann test was negative. The accessory sinuses were normal. Six years before examination she fell on the temporal side. Subconjunctival intervention, by Knapp's method, showed evidence of a large rift in the temporal and upper bony walls of the orbit. Sclerotic masses were removed from this rift by operation. Intervention proved a failure.

N. BLATT.

Pharmacology

RESEARCHES ON THE SUBVITAL PROCESSES IN ISOLATED EYES. S. S. GOLOWIN, Ztschr. f. Augenh. **70:** 265 (Feb.) 1930.

Many interesting experimental observations are recorded by Golowin from his work on perfused animal eyes which were removed from the orbital socket. Like many previous observers he notes that at their best such experimental procedures are crude. Nevertheless, the results are suggestive and lead to a better understanding of the action of certain pharmaceutic preparations, the production and movement of the aqueous humor and the origin of the intra-ocular pressure.

From his work he concludes that eserine, pilocarpine, histamine and epinephrine have a definite constricting effect on the blood vessels and lower the intra-ocular pressure. The reaction almost approximates a spasm and does not last long. Atropine, cocaine and caffeine show no definite alteration in the blood vessels. The author believes, therefore, that the vasodilatory effect is controlled by a central area rather than by a local reaction as noted with the constrictors. The constricting apparatus of the blood vessels of the eye possesses no great potential energy and without the aid of the nerve center is usually relaxed. He therefore considers the eye as an organ in which vasoconstrictor reactions predominate. A stimulation of the ciliary body produces an increased intra-ocular tension and a diminution of outflow of aqueous humor. The regulating mechanism of the eye is probably local and central.

The eye absorbed 11.4 per cent of solid substance perfused through it when uninjured and 14.3 per cent when injured. When this perfused fluid from a healthy eye was flushed through a second eye it lost 2.5 per cent, whereas that of the injured eye lost 0.9 per cent. In view of this retention, Golowin assumes that the connective tissue stores up this solid matter.

He believes that there is a vital permeability of the wall of the vessel, "barrière apparat," which alters itself with physiologic demands and absorbability of the interfilamentous part of the intervening tissue of the ciliary body. It is regulated by a product of the ciliary epithelium which seems to have a hormonal character. The intra-ocular pressure depends principally on the direct blood pressure and on the osmotic phenomena of the fluids. The regulation of the intra-ocular pressure depends on

the wall of the blood vessel. The author states that this experimental work corroborates his opinion that glaucoma is a disease characterized by the disturbance of the equilibrium of the intra-ocular presure which is produced by alterations of the walls of the vessel.

A. M. YUDKIN.

Physiology

AMMONIA FORMATION DURING ILLUMINATION OF THE RETINA. H. RÖSCH AND W. TE KAMP, Ztschr. f. physiol. Chem. **175:** 158, 1928.

It was shown by Warburg, Prossener and Negelein (*Biochem. Ztschr.* **152:** 309, 1924) that the surviving retina of a frog forms ammonia under anaerobic, and to a still greater degree under aerobic, conditions. The present paper deals with the question whether the retina forms ammonia under the influence of its adequate stimulus, light, similar to the formation of ammonia in muscle during contraction.

Frogs were kept in a completely dark room for at least twelve hours. They were decapitated in red light, the eyes enucleated and all extraneous tissue freed from the globe. The posterior segment was cut away and after removal of the vitreous the segment in the form of a cup was placed in a suitable vessel where the ammonia liberated could be determined.

The technic for the determination of ammonia is given in full. In this fashion the amount of ammonia liberated in the dark during the course of ten minutes was determined in each of a series of eyes. The amount of ammonia differed considerably from one set of eyes to another, but the difference between the two eyes of a pair was exceedingly small, the largest difference being 13 per cent. A second series was undertaken in which one eye was illuminated for ten minutes with a 340 candle power filament light at a distance of 80 cm., while the other eye was kept in the dark. The effect of heat was carefully excluded.

A relatively enormous increase in the amount of ammonia formed occurred in the illuminated eye. The lowest difference between the two eyes was 74 per cent.

Further experiments showed that a suspension of freshly ground up retina also formed a considerable amount of ammonia. The addition of adenosin phosphoric acid led to a considerable increase in the formation of ammonia, whereas the addition of urea caused no increase.

F. H. ADLER.

Refraction and Accommodation

VARIATIONS IN REFRACTION OF THE VISUAL AND EXTRA-VISUAL PUPILLARY ZONES. G. H. STINE, Am. J. Ophth. **13:** 101 (Feb.) 1930.

This article does not lend itself to abstracting, and must be read to be appreciated. The dilated pupil is divided into a central or visual zone surrounded by four extra-visual zones, namely, the superior, the inferior, the nasal and the temporal. Skiascopic examinations were made of these zones in 277 normal eyes, and the following summary was made:

1. In the vast majority of eyes there is considerable variation of refraction between the visual and the extra-visual zones of the pupil. This difference varies in different persons, in the two eyes of the same person and in the quadrants of the same eye.

2. The variations are chiefly "symmetrical" positive aberration, "symmetrical" negative aberration and mixed aberration (scissors movement).

3. The superior and nasal quadrants are the most highly refracting, the temporal quadrant is only slightly less so, and the inferior quadrant is the weakest of the four.

4. The asymmetrical aberration producing scissors movement is chiefly in the upper and lower quadrants, the superior quadrant being the more myopic.

5. The maximum difference between quadrants in an individual normal eye was 8 diopters, and the highest degree of aberration was 7.5 diopters.

6. The type and degree of aberration are not dependent on the kind or amount of refractive error. Nor is the size of the pupil of any significance with respect to the incidence of the different forms of aberration.

7. While positive aberration is the most frequent observation, especially in adults, negative aberration and the marked asymmetry of mixed aberration, both of which present the most disturbing skiascopic appearances, are met with, on the whole, in more than 40 per cent of children. One must remember that it is in children that one is most dependent on skiascopy. "Symmetrical" negative aberration was not found in any patient over 19 years of age.

8. The lens is a most important factor in producing the aberrations of the eye. It is reasonable to suppose that the tendency to negative aberration and lower positive aberration in the juvenile eye, and to higher positive aberration in the adult eye, is indicative of the growth and changes in refractivity of the cortex and nucleus of the lens.

9. The aberrations of the eye must be reckoned with in ophthalmoscopy, and objectively and subjectively in applied refraction.

10. Skiascopy is the most practical method of determining these defects, and should be used as a routine measure to study the refraction of all pupillary zones of the eye. W. S. REESE.

Retina and Optic Nerve

RECURRENT HEMORRHAGES INTO RETINA AND VITREOUS: CALCIUM DEFICIENCY AS POSSIBLE CAUSE. CHARLES A. YOUNG, Am. J. Ophth. **13:** 125 (Feb.) 1930.

The author reviews the literature and discusses the prognosis and treatment. He reports three cases. In the first the blood calcium was extremely low, and following calcium therapy the patient had no further attacks. In case 2 there was also lowered blood calcium; abscessed teeth complicated the situation. Case 3 was considered tuberculous in origin. The following conclusions are made:

1. Recurrent hemorrhages into the retina and vitreous are evidently the result of one or more of many widely different pathologic phenomena, and it may be that two or more factors are necessary.

2. Calcium deficiency should be kept in mind as a possible cause.

3. In one case calcium therapy not only seemed to prevent further hemorrhages, but very much improved the patient's general condition.

W. S. REESE.

RETINITIS PUNCTATA ALBESCENS AND PIGMENTARIA. PAULINA SATANOWSKY, Arch. de oftal. de Buenos Aires **5:** 28 (Jan.) 1930.

The author observed the development of retinitis punctata albescens from pigmentary retinitis, which she considers a transition from a hypertrophic into an atrophic condition.

C. E. FINLAY.

A CASE OF UNILATERAL HYPOPLASIA OF THE OPTIC NERVE IN AN OTHERWISE NORMAL GLOBE. CARL VELHAGEN, Arch. f. Augenh. **102:** 382 (Dec.) 1929.

The author describes the appearance of the optic nerve in a child, aged 9 years. Both eyes were normal save for the right papilla, which was only from one-ninth to one-tenth the size of the left papilla, which was normal. The optic foramen on the right side was about 1 mm. smaller in diameter than the left. No difference in the macula could be seen in either eye with red-free light.

F. H. ADLER.

THE COURSE OF THE RETINAL VESSELS. H. GAUSS, Arch. f. Ophth. **123:** 427 (Jan.) 1930.

Statistical studies of the frequency of tortuosity in 150 patients led the author to divide his material into four groups, namely: (*a*) those with normal vessels, 70.7 per cent; (*b*) tortuosity of arteries and veins, 6 per cent; (*c*) tortuosity of the arteries only, 15.3 per cent, and (*d*) tortuosity of the veins only, 8 per cent.

The normal type is characterized by long and rather flat curves which must not be too frequent. The age of the patient has no influence on the frequency of tortuosity. The relation between refraction and the incidence of tortuosity is interesting. Tortuosity is rare in myopia of from — 4 to — 10 diopters. At the point that indicates the frequency of tortuosity in cases with a myopia of 3 diopters, the frequency curve rises rapidly. The same height is reached at the point that corresponds to a fraction of plus 3 diopters. Between plus and minus 3 diopters there is a minimum at plus 1 diopter. In the great majority of all the cases the tortuosity must be considered congenital.

P. C. KRONFELD.

THE REFLECTION PHENOMENA ON THE SURFACE OF THE RETINA. A. KREIKER, Arch. f. Ophth. **123:** 446 (Jan.) 1930.

The paper deals with the morphology, optics and physiology of the reflection phenomena on the surface of the retina. As to the light reflex on the vessels, the author objects to the opinion of Dimmer, who thought

that it was due to the axial stream in the blood vessels. Kreiker explains it like all the other reflex phenomena on the retina, as a reflection which takes place from the membrana limitans interna. The circumfoveal reflex is caused by the convexity present on the edge of the fovea. Relations between the shape and size of the circumfoveal reflex and the visual acuity are often present. In amblyopic eyes a small circumfoveal reflex and some reflection in the fovea itself are frequently found, indicating that the fovea is smaller and flatter than normally.

The reflection from the surface of the retina shows—especially in cases of partial atrophy (tabes)—a mosaic structure which Kreiker interprets as the basal cones of Müller's cells. In the macular area a fan-shaped reflex is sometimes seen, indicating that in these cases the fovea is funnel shaped.

P. C. KRONFELD.

CAVERNOUS ATROPHY OF THE OPTIC NERVE. Y. KOYANAGI, Arch. f. Ophth. **123:** 537 (March) 1930.

The author and his co-workers studied cavernous optic atrophy in animals (experimental exophthalmos and experimental orbital tumors) and in human beings (orbital tumors, myopia and glaucoma). In the early stages of cavernous atrophy there is merely atrophy while in the later stages proliferation of neuroglia occurs. This point differentiates cavernous atrophy from all the other types of optic atrophy in which the proliferation of neuroglia proceeds parallel with the atrophy.

Cavernous atrophy in man does not occur in glaucoma only. This opinion is based mainly on the study of cases of orbital tumors in which, without any clinical symptoms or other histologic signs of glaucoma, the peripheral end of the optic nerve frequently showed cavernous atrophy. Among thirty-three cases of orbital tumors the author found (after careful clinical studies) only one case with definite glaucomatous symptoms. He therefore concluded that the cavernous atrophy in his cases of orbital tumors could not be due to the presence of glaucoma, but was caused by the dislocation of the eyeball. In the majority of his cases of orbital tumors the tension was lower than normal, but returned to normal after removal of the tumor.

As to the cause of a cavernous atrophy, the author believes in the mechanical theory and objects to the toxic theory of Elschnig. In cases of orbital tumors the fibers of the optic nerve are stretched and break at the place of least resistance and least protection. The same mechanism seems to occur in glaucoma and myopia.

In man, the optic nerve fibers are intimately connected with the clear portion of the lamina cribrosa. A displacement of the glial lamina backward will be sufficient to stretch and finally to break the optic fibers.

P. C. KRONFELD.

DETACHMENT OF THE RETINA CAUSED BY INJURY. R. CORDS, Klin. Monatsbl. f. Augenh. **84:**222 (Feb.) 1930.

In the author's opinion, an accident is rarely the cause of a detachment of the retina. It would not have resulted without other contributing factors. Since most of these eyes are diseased, an apparently irrelevant accident may produce a detachment. Cords thinks it would

be a good policy to protect this class of people against ultimate loss of their sight by allowing them a state pension. The following causes, mentioned in the order of their importance, may lead to detachments: the sequelae of perforating wounds, contusion of the globe, blows on the head, violent shocks of the body, physical strain. Detachment may follow some time later in the first two types. Definite connections between detachment, disturbance of the vision and the accident must be proved in the last three categories. Shocks of the body may be held responsible for the detachment in predisposed eyes if the shock was really violent and if vision failed within a week afterward.

K. L. STOLL.

TREATMENT OF DETACHMENT OF THE RETINA BY IGNIPUNCTURE. J. MELLER, Ztschr. f. Augenh. **70:** 207 (Feb.) 1930.

A careful review of the methods utilized hitherto for the repair of detachment of the retina is supplemented by the author's own experience with the application of ignipuncture in a number of cases. He notes that the procedure is not satisfactory in all kinds of detachment of the retina. The most gratifying results are produced in detachments of from a few days' to a month's duration. The prognosis is favorable particularly when a tear is present and the edges are coapted. This, however, does not preclude the attempt to repair the detachment by this method when a tear is not visible, for he has improved several cases in which the tear was not seen. Detachments accompanying high myopia, which show definite tears because of choroidal adhesions, should be treated by puncturing rather than by conservative methods. When the lesion is in the macular region, the results are not satisfactory.

This operation is not recommended to all practitioners of ophthalmology, but should be conducted in well regulated ophthalmic institutions where all necessary equipment is available and where true localization of the tear or hole can be undertaken and rigid investigation of the underlying factors producing the lesion can be made. The patient must remain in the hospital until complete union of the tissue has taken place. An ill chosen puncture with a thermocautery will only defeat the purpose The author heralds Gonin's treatment for detachment of the retina as a worthy contribution to ophthalmic science.

A. M. YUDKIN.

Trachoma

THE VALUE OF CHAULMOOGRA OIL IN THE TREATMENT OF TRACHOMA AS COMPARED WITH COPPER SULPHATE OR MERCURIC PERCHLORIDE. R. D. WILSON. Third Ann. Rep. Res. Dept. Giza, Mem. Ophth. Lab., Cairo, 1928, p. 54.

From two years' experience the following conclusions are drawn: 1. Chaulmoogra oil is not a specific agent in the treatment for trachoma, but it possesses valuable antitrachoma properties. 2. The method gives results similar to those obtained by the usual methods of treatment: (*a*) In the treatment for stage 1 the oil is perhaps inferior to copper sulphate, but both are unsatisfactory; (*b*) in the treatment for stage 2

it appears preferable to corrosive mercuric chloride. 3. In neither stage is the period of treatment definitely shortened by its use. However, it gives the patient less discomfort.

W. ZENTMAYER.

STATISTICAL REFLECTIONS ON TRACHOMA IN SCHOOL CHILDREN. PUSCARIU, Cluj. med., 1929, no. 9.

From 1916 to 1928, 391 students with trachoma, from 7 to 20 years of age, besides 100 other persons with trachoma, were treated; 258 of the first group suffered from trachoma of the first and second degrees, 21 from trachoma of the third degree and 12 also from pannus. In the second group, 12 had trachoma of the first, 37 of the second and 5 of the third degree, 46 had pannus and 9 had entropion. Hence, trachoma is more frequent in students, although pannus among them is rarer. In all instances infection occurred in the family. A determining factor in the origin of pannus is individual resistance.

N. BLATT.

Tumors

TWO NEUROFIBROMAS IN ONE EYE. G. R. CALLENDER and C. A. THIGPEN, Am. J. Ophth. **13:** 121 (Feb.) 1930.

In 1917, a woman, aged 35, in good health, noticed a small yellow spot in the iris of the left eye. This gave no trouble and she was assured by an ophthalmologist that it was not serious. The spot grew larger and finally vision became affected. In 1928, when first seen by the author, vision was 20/200. There was a tumor of the iris involving the ciliary body and extending into the vitreous. The pupil was slightly enlarged and irregular, and the vitreous was so hazy as to preclude satisfactory ophthalmoscopy. Tension was normal. Enucleation was advised but deferred until a glaucomatous attack supervened, when it was done immediately. The eye showed a firm white tumor of the ciliary body extending into the anterior chamber for 8 mm. The tumor was 4 mm. broad and 2.5 mm. thick. On the other side of the eye there was a tumor of similar appearance, roughly globular, about 14 mm. in diameter, which projected about 7 mm. outside the globe and an equal distance into the vitreous. Microscopic examination showed the tumors to be made up of spindle-shaped cells often arranged in whorls, occasionally having a palisade arrangement around a hyaline or fibrillar matrix. In none of the sections was it possible to demonstrate a direct connection between the ciliary nerves in either tumor, and no nerve fibers were found in the tumor although differential stains could not be used.

W. S. REESE.

TUMOR OF THE IRIS. RÓMULO R. GIL and BAUDILIO COURTIS, Arch. de oftal. de Buenos Aires **5:** 11 (Jan.) 1930.

The author reports a case that he considers a typical sarcoma of the iris with normal vision. He reviews the literature on the frequency, etiology, symptomatology and pathologic anatomy. He advocates a careful expectant treatment. He has had this patient under observation for a year.

C. E. FINLAY.

CONTRIBUTIONS TO THE STUDY OF CHOROIDAL SARCOMA. P. VANCEA, Cluj. med. **11:** 16 (Jan.) 1930.

A case of bilateral optic neuritis with central scotoma is described. In the further clinical course a detachment of the left retina occurred. Only then was a choroidal sarcoma taken into consideration. The enucleation confirmed the clinical assumption. Orbital recurrence required the exenteration of the orbit. After some months metastases to the bone and death occurred. The author feels himself justified in assuming the optic neuritis to have been the initial symptom of the choroidal sarcoma and due to toxic action. N. BLATT.

Uvea

TRAUMATIC LESIONS OF THE PIGMENT EPITHELIUM OF THE IRIS. D. CATTANEO, Ann. di ottal. e clin. ocul. **58:** 11 (Jan.) 1930.

The author reports three cases of this condition, which has been rarely reported, but which he believes is more common than is usually supposed, as it may be detectable only by slit-lamp examination by the method of retro-illumination. The beam of the slit-lamp is thrown on the lens, when small defects in the overlying iris can be seen.

Two of the author's patients suffered from contusions with small objects. In the first, traumatic cataract was present and a small radial rupture of the pigment epithelium was seen only by the method described. The area was not transparent on ophthalmoscopic examination, and the iris was otherwise normal. In the second case, the pupil was immobile and round except for one area in which a quadrilateral area of pigment epithelium adhered to the lens capsule, projecting beyond the iris stroma. By retro-illumination a defect in the pigment epithelium could be seen corresponding to the pigmented area.

In the third case a patient with a penetrating wound and a traumatic cataract showed a similar detachment of the pigment layer, the pupillary border being adherent to the lens and its peripheral border floating freely in the anterior chamber. While in this case the disturbance of the pigment epithelium may have been produced directly by the penetrating object, in the other cases the author believes that it is best explained by sudden pressure of the aqueous on the iris stroma with stretching of the scleral ring. As the pigment epithelium is less elastic than the iris stroma, it ruptures and the latter is stretched away from it.

S. R. GIFFORD.

Visual Tracts and Fields

DIAGNOSTIC VALUE OF BINASAL HEMIANOPIA. AMADEO NATALE, Arch. de oftal. de Buenos Aires **5:** 19 (Jan.) 1930.

The author reports a case of binasal hemianopia occasioned by a postgrippal retrobulbar optic neuritis. C. E. FINLAY.

THE MANNER OF PENETRATION OF THE FIBERS OF THE OPTIC TRACT INTO THE EXTERNAL GENICULATE BODY. M. BALADO and E. FRANKE, Arch. de oftal. de Buenos Aires **5:** 51 (Jan.) 1930.

These observations are the result of examinations of the external geniculate body in two cases of lesion of the optic tract and in one case

of total destruction of the occipital lobe in human beings. In the former instance the degenerated fibers, stained with scarlet red, could be followed into the external geniculate body; in the latter the fibers were not affected by the secondary degeneration. The authors confirmed Cajal's observations in the cat, the fibers from the optic tract being distributed along the inferior and internal portion of the external geniculate body. This study only comprises the myelinated fibers; the unmyelinated fibers will be studied separately. C. E. FINLAY.

Therapeutics

TREATMENT OF EYE DISEASE BY TUBERCULIN. W. CAMAC WILKINSON, Brit. M. J. **1**: 1090 (June 14) 1930.

The author has been observing the effects of tuberculin in the diagnosis and treatment of certain refractory diseases of the eyes, such as chronic conjunctivitis, iritis, cyclitis, scleritis and retinitis. He states that tuberculous lesions of the eye, like the secondary lesions of syphilis, occur in the secondary stage when tubercle bacilli are circulating in the blood. Therefore, one must not expect any pulmonary lesions. The condition in the eye develops slowly, tends to recur and may lead to blindness. Some of the cases were referred to him by ophthalmologists, who controlled the changes in the eyes. Nine cases are reported. Apparently, the intracutaneous method for diagnosis was used. Treatment consisted in the use of tuberculin T.R. and T.A.F. He mentions four other cases sent to the tuberculin dispensary for diagnosis in which there was no reaction to intracutaneous or subcutaneous tests. This shows that not all people react to tuberculin. The author believes that these cases show that there are patients with inflammatory diseases in the eye who do not benefit by the ordinary methods of treatment. Many of them react to tuberculin, and treatment with tuberculin produces decided improvement; in some cases the trouble is arrested. He considers the use of tuberculin according to the methods outlined as being entirely harmless, and thinks that a wider trial of these methods should be made.

Unfortunately, the nine cases are so briefly reported that it is not possible to form any idea of the severity of the lesion of the eye, or even of the actual diagnosis.

Stobie (*Brit. M. J.* **2**: 1195, 1930) questions whether it is possible to make a diagnosis of a tuberculous disease of the eye solely on a general tuberculin reaction, and states that in none of the nine cases described in Dr. Wilkinson's article was there any mention of a focal reaction. Stobie thinks that the danger of these focal reactions has been much exaggerated. He regards the analogy between the syphilitic and tuberculous infections as picturesque and rather conjectural. Furthermore, the fact that the patients made excellent progress under treatment with tuberculin in no way substantiates the claim that the lesions were tuberculous.

The author speaks of investigations he had made with Mr. P. H. Adams, both with the subcutaneous injection of tuberculin and with the blood complement fixation method, to arrive at a diagnosis in obscure cases of diseases of the eyes. The results, however, were so inconsistent that they were of no practical value.

Stobie believes that the focal reaction is essential to determine the cause of the condition of the eye. Patients with this reaction should be treated with tuberculin and will do well; in those in whom only the general reaction was positive, a nonspecific antigen was more rapid in action than tuberculin.

The abstractor is in complete agreement with Dr. Wilkinson that tuberculin should be used in doubtful cases of chronic disease of the eye.

ARNOLD KNAPP.

TECHNIC OF PHYSICAL THERAPY IN KERATITIS PARENCHYMATOSA. F. AURELIANO, Ann. di ottal. e clin. ocul. **58:** 45 (Jan.) 1930.

The roentgen rays of longer wave length tend to produce necrosis; those of short wave length to stimulate cicatrization. Hence, in interstitial keratitis short rays are used. A dosage of 400 R. units, 180 kilovolts with 0.5 mm. zinc and 3 mm. aluminum filters being used, is divided over four treatments given a week apart. This is followed by galvanic ionization with solutions of zinc or copper over the closed lids, about thirty such treatments of thirty minutes each being given on alternate days. Besides this, treatments with ultraviolet light and general light baths are given at the same time. A new series of roentgen treatments is begun after sixty days, this time utilizing the secondary rays from iodine or copper solutions. According to the author, the results are slow but definite.

S. R. GIFFORD.

NEW PROCEDURES IN OPHTHALMOLOGIC THERAPEUTICS. G. HORAY, Orvosi szemle **2:** 166 (June) 1929.

The author gives a synoptic description of recent therapeutic methods applied by the general practitioner in many cases. The diseases of the eye described are well selected, and the methods recommended to oculists in practice have long been adopted by most of them. In local chemotherapy ethylhydrocuprein is mentioned for ulcus serpens and in intravenous chemotherapy methenamine for iritides. For trachoma the chemical and mechanical remedies hitherto applied are advocated. For glaucoma extracts of endocrine glands in the form of polyglandular tabloids are praised, whereas an epinephrine substitute, glaucosan, or ergotamine tartrate ought not to be left in the hands of the general practitioner. For syphilitic diseases of the eye, the combination of specific and protein therapy is mentioned. In tuberculosis of the eye percutaneous tuberculin therapy has stood its ground. Altogether, a tendency to conservative therapy is shown in this paper, in some respects, perhaps, with good reason.

N. BLATT.

THE OPTICOPHYSIOLOGIC AND THERAPEUTIC VALUE OF TINTS. N. BLATT, Orvosi szemle **2:** 271 (Sept.-Nov.) 1929.

Individualization should be observed in a prescription of colored glasses and the object of the prescription kept in view; i. e., (1) whether the glasses are to be used only preventively for protection against the harmful action of certain sources of light, or (2) whether they are to act therapeutically, by the exclusion of certain luminous rays, in the

various diseases of the eye particularly sensible to them. In the first instance the optical and physical condition of the source of light has to be taken into account, and in the second one also the nature and degree of the ocular disease. Not only should the glasses prescribed be selected according to their optical quality, but also the quantitative degree of their optical properties should be measured exactly if possible.

It would be a mistake to prescribe goggles indiscriminately, for not all rays of light are harmful to the eyes, especially not the normal rays of sunlight; also the qualitatively harmful rays of light must first reach a certain optically quantitative degree in order to be able to injure a healthy eye. On the contrary, one does harm to the healthy eye by withholding the innocuous sunbeams from it, because the physiologic luminous processes taking place in the eyes are retarded, for pigment migration and the contraction of the visual elements, as well as the oxidative processes occurring in the retina, are possible only under the action of light.

The injuriousness of a source of light is also dependent on the opticobiologic affinity of its luminous rays for the ocular tissues. The ultraviolet and infra-red rays may also be injurious. Injury is done to the human eye by luminous rays if reflected by sun-beaten glacier surfaces and by luminous rays emanating from an electric carbon arc or mercury vapor quartz lamp. There the ultraviolet rays play the paramount part. Other routine sources of light as a rule do not contain any injurious luminous rays. The luminous rays produced by red-hot glass in glassworks are also injurious, the infra-red rays being answerable for glassblowers' cataract.

In the second part of the paper the various tints in use are discussed. Only those glasses are able to cut off the injurious luminous rays which, owing to physical properties, are able to absorb the rays. Experiments undertaken by means of the photographic method showed that the chemical action of the luminous rays could best be avoided by red glasses. The same effect is obtained by orange-colored glasses; these absorb all ultraviolet rays as well as the short-waved rays of the visible spectrum. However, since these glasses dull all colors and as the eyes are not sensible enough to the red light, red glasses have been replaced in practice by greenish-yellow ones bringing about almost the same effect; e. g., the greenish-yellow glasses of Fieuzal, the grayish-green ones of Hallauer, the brownish-yellow ones of Motais, the greenish-yellow Euphos-glasses, the yellowish-green Enixanthos glasses, Crookes' glasses, and the Delhi green glasses. For the absorption of ultraviolet rays the Sinuval glasses, the Sanoscope glasses, the Esculin glasses, the Anactin glasses, and the Geaphot glasses are suitable. For the absorption of the infra-red rays and part of the visible long-waved rays glasses containing ferrous oxide are suitable, such as the Robon, Uropunctal, Uviol, and Nowiweld glasses. For the absorption of the visible spectrum the neutral gray and the grayish-brown Umbral glasses are most suitable.

In the third part of this paper the prophylactic necessity for wearing colored glasses is emphasized, and in the fourth part their therapeutic use. Preventively the wearing of goggles is indicated at the beginning of one's residence in the tropics, during journeys on very sunny days, sun baths, observation of solar eclipses, and touring on snow, ice and

glaciers. The eyes ought to be protected from the luminous rays due to the various artificial sources of light mentioned and while working in glassworks and iron foundries.

In various pathologic conditions colored glasses ought to be worn. They are contraindicated in cases of blepharitis and conjunctivitis, but indicated in eczematous keratoconjunctivitis. In trachoma protective glasses are prescribed only when corneal ulcers and strong photophobia are present. It should be borne in mind that in trachoma, light can also act therapeutically. Colored glasses are necessary in vernal conjunctivitis, lymphatic and rheumatic diseases of the cornea, parenchymatous keratitis, and in all inflammatory diseases of the iris, ciliary body and choroid. In glaucoma the use of protective glasses is doubtless contraindicated, as the miotic action of light is thereby precluded. Albinos or persons with retinitis are in need of protective glasses with a marked power of light absorption, as are persons with neuritis. In the selection of protective glasses for therapeutic purposes, care should also be taken to determine their power of absorption and degree of color saturation; the latter factor has to become adjusted to the intensity, pathologic type and degree of the disease. Of course, the therapeutic action of protective glasses is only indirect, in that relatively injurious rays of light are thereby cut off, so that rest is secured for the eye and both the natural healing powers of the system and the applied artificial healing factors can better display their curative effect on the eye.

N. BLATT.

Society Transactions

EDITED BY DR. GEORGE S. DERBY

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY AND ACADEMY OF DENTISTRY

W. F. C. STEINBÜGLER, M.D., *Secretary*

Joint Meeting, April 3, 1930

E. F. KRUG, M.D., *Chairman*

ORAL INFECTIONS AND THEIR RELATION TO DISEASES OF THE EYE

The evening was devoted to a consideration of this subject and the following papers were presented:

1. DENTAL INFECTION IN DISEASES OF THE EYE. DR. W. F. C. STEINBÜGLER.

2. INFECTIONS OF THE MOUTH AND THEIR RELATION TO DISEASES OF THE EYE FROM THE POINT OF VIEW OF A GENERAL PRACTITIONER OF DENTISTRY. DR. H. W. GILLETT.

These articles appeared in full in the August issue of the ARCHIVES (**4:** 220 and 228, respectively).

3. ORAL INFECTIONS AND THEIR RELATION TO DISEASES OF THE EYE FROM THE POINT OF VIEW OF THE ORAL SURGEON. DR. H. S. DUNNING.

This article appears in full in this issue of the ARCHIVES, p. 315.

DISCUSSION

DR. CONRAD BERENS: When the ophthalmologist is confronted by an inflammatory lesion of the eye, may he say definitely that dental infection is a factor? Tuberculosis, syphilis and gonorrhea must first be excluded, and in the case of tuberculosis that may be exceedingly difficult, since even the delicate Mantoux test may be negative and yet tuberculosis may be present. Having ruled out these three diseases, several other foci of infection are usually found, and unless fixation tests from bacteria of dental origin afford a means for making a specific localizing diagnosis, it is impossible to exclude them as factors. When the sinuses, tonsils, prostate, gallbladder and other foci can be excluded, the intestines can rarely be positively ruled out.

Having determined the possible dental origin of the inflammatory condition of the eye, how should one discuss these observations with the patient, and how should one evaluate the reports of the dentist, the specialist in oral diagnosis and the oral surgeon? In the present state of knowledge, it seems impossible to state positively that the lesion of the eye is caused by the dental infection, but one may tell the patient that the probable dental infection is the only factor found, or that the

teeth are one of several factors. As the dental infection can usually be completely eliminated, which is not always true of several of the other foci of infection, it may be advisable to commence with the teeth.

If several teeth are to be extracted, the patient should be warned to have no more than two extractions at one time. One patient, in spite of this advice, had eight teeth extracted at once, and then attended a directors' meeting. He was put to bed with a heart attack the next day, and the iritis, which had been mild in one eye, became fulminating in both eyes and was complicated by glaucoma. This patient was confined for several months as the result. I am convinced from several unfortunate experiences that Dr. Dunning's rule of not curetting after extraction should be more generally followed.

I wish to call attention to a series of fifty-four cases of established dental infection concomitant with specific diseases of the eye.

Of the fifty-four patients, fifty-one apparently improved, thirty-nine with vaccine treatment and twelve without vaccine treatment. Three patients showed no improvement. In one instance vaccines were used, while in the other two no vaccine was used.

The value of these data in regard to the effect of treatment is questionable when one realizes that local and general medical treatment was used and other foci were also cared for, frequently with the addition of vaccines and filtrates applied or injected locally in cases in which chronic sinusitis was a complicating factor.

Although it may seem that many conditions of the eye are improved by extracting teeth, we have seen the same diseases cured by medical treatment alone, or possibly by nature, for the tendency of almost every disease is to improve. A disease of the eye can develop if only resistance is lowered, and much absorption of infection can occur from the teeth without producing a lesion of the eye, provided resistance is adequate.

Some authorities still believe that inflammatory diseases of the eye are not caused by sinus or dental infection, and although I hold the opposing view, and believe that many postoperative complications are also caused by these infections, conclusive proof of either contention is difficult to establish, and a lengthy discussion of this phase of the subject would be out of place here.

DR. JAMES G. DWYER: I believe that the pendulum has swung too far as far as focal infections are concerned. Focal infection is not found in young people, it is essentially a condition that must go on for years before it manifests itself. Protein sensitization of various tissues may go on for years and then suddenly be lighted up from one cause or another. The worst focal infections of the eye are those in men and women who had their tonsils imperfectly removed and a big piece has been left behind, scar tissue was formed, pus pumped in, and then sudden infection takes place. The importance of pus under pressure is great.

DR. ARTHUR H. MERRITT: Pulps of vital teeth may become the seat of chronic infection without objective or subjective symptoms. They should always be considered as a source of metastatic infection. The primary focus of pulp infection can frequently be treated successfully, infection eliminated and the tooth preserved. Pulpless teeth form the commonest and most dangerous source of dental infection. No treatment of the tooth can ever be wholly satisfactory in these cases. Pyorrhea is of great importance. There is no disease more easily pre-

vented, and if treated before too far advanced it can be permanently cured.

Dr. J. O. McCall: I believe that while harm is done by the pus and filth that accumulates around the teeth being carried into the stomach, and while loss of teeth with diminished or absent masticating power is a factor in causing indigestion, yet that a more important factor is the infection of blood and lymph coming from infected periapical lesions. Improvement follows the extraction of such teeth.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

H. Dickinson, *Reporter*

Jubilee Meeting, April 3, 4 and 5

Mr. Leslie Paton, F.R.C.S., *President, in the Chair*

Presentation of the Nettleship Medal to Miss Ida Mann. Mr. Leslie Paton.

The president presented the Nettleship Medal to Miss Ida Mann for her investigations into the Embryology of the Eye, her work on which had extended for ten years. He remarked on the excellence of her work in this field, and said it was a great pleasure to have had her as a co-worker at St. Mary's Hospital. Miss Mann replied suitably.

Some of the Factors Controlling the Position and Movements of the Eyes. Mr. Leslie Paton.

In man and other animals with frontally placed eyes and binocular vision, the retinal stimuli play a predominant part in the control of the position and movements of the eyes. In lower types of mammals and in other animals with laterally placed eyes, other factors gain greater prominence, and the most important of these are the reflex stimuli originating from the labyrinth and from the muscles of the neck. These factors are also present in man, but they are not so easily made manifest, though when their proper functioning is interfered with, signs and symptoms result which are often of grave importance and which are usually difficult to interpret. Among the most important of these signs and symptoms are vertigo, nystagmus and nausea or actual vomiting. These lower controls are best studied in the rabbit or guinea-pig. The basic nature of the labyrinthine structure giving rise to this control remains constant throughout the animal kingdom, from the simple statocyst of the invertebrate to the complex organ of Corti in the human ear. Histologically, it is built up of oval or goblet-shaped cells with projecting sensory hairs lying in a framework of supporting cells and supplied from a plexus of underlying nerve fibers. Functionally, these are in a state of constant unsleeping activity, and the strength of the stimuli sent out from them varies inversely as the pressure on them. The pressure is transmitted to the hairs by simple otoliths, otolith membranes, gelatinous capsules or membrane tectoria. These all lie in a fluid medium which, in the case of fishes, may be in direct continuity with the water in which the animal swims. The pressure may be varied

by gravitation as in the case of the sacculus and utriculus or by movement, either progressional or rotational as in the case of the semicircular canals, or vibrational as in the case of the organ of Corti.

The determination of the position and movement of the eyes is only a small part of the function of these organs. Their most important function is the maintenance of equilibrium and of the tonicity of the body musculature. The classic experiment of Kreidl with the crustacean *Palaemon* exemplifies the mode by which equilibrium is maintained. When in this animal small grains of iron were substituted for the normal otoliths, the equilibrium of the animal was determined by magnetic attraction, instead of by gravitational attraction. In fishes, the need for maintenance of equilibrium is met by the elaborate mechanism of the labyrinth, sideline organ and head canals. Here there is no acoustic mechanism but an extremely delicate reflex response to slight variations in fluid pressure. A similar delicacy of mechanism exists in bats, to enable them to avoid small obstacles in the dark, a power which they lose when their ears are hermetically sealed.

The control of this organ on eye positions and movements is best studied in rabbits or guinea-pigs. Here it is found that every position of the head in space has a corresponding position of the eyes in the orbit and every position of the head relative to the trunk also produces its corresponding position of the eyes in the orbit. So there is a direct control by the labyrinthine stimuli and by proprioceptive impulses from the muscles of the neck on the positions of the eye. Investigation shows that the labyrinthine impulses controlling position emanate from the maculae of the sacculi and utriculi, and that the stimuli are continuous but are varied in force inversely with the pressure of the otolith membranes on these maculae. When the pressure is greatest the stimuli are least. The sacculus and the utriculus each link up with definite eye movements, either up and down movements or rotational movements but not with lateral deviation movements. On the other hand, the proprioceptive impulses from the muscles of the neck exert a controlling influence on all classes of eye movements including lateral deviations.

In animals with frontally placed eyes, overlapping fields and binocular vision the dominance of the retinal controls obscures the controls of the labyrinth and the muscle of the neck, but in decerebrate animals they are manifest, and it is found that their nature is the same, though the linking up of the movements with the sacculus and utriculus, respectively, has undergone an alteration consequent on the alteration of the position of the eyes.

Recent researches by de Kleijn and Versteegh have rendered it doubtful whether the separation of function in the different parts of the labyrinth is as definite as has been thought. It would almost seem as if when the sacculus is destroyed other parts of the labyrinthine apparatus act in vicarious fashion and replace the lost saccular function, so that, if this work is confirmed, the whole question is again pushed back into its original obscurity.

It is evident that the stimuli emanating from the sacculus and utriculus depend on gravitational pressure and may be called graviatatic. The stimuli from the muscles of the neck vary with their condition of contraction or relaxation and may be called tonic. The stimuli from the semicircular canals initiate movements in the eyes and are themselves

initiated by variations in the fluid pressure in the canals acting on the gelatinous capsules covering the cristae ampullae. So we may call the activity of the semicircular canals kinetic and to that extent they seem to be in opposition to the sacculus and utriculus which seek to maintain positions of the eyes from which the activities of the semicircular canals would displace them. But the disposition of the semicircular canals on the two sides is such as to maintain a balance apart from causes which vary the fluid pressure. When this balance is disturbed, nystagmus results. In vestibular nystagmus the sacculus and utriculus play a part as well as the semicircular canals.

Anatomically, the paths concerned in all these controls of eye movements and body equilibrium are complex, and impulses may travel to their final common path by more than one route. Some of these paths are known, but many are yet obscure. Some of them are purely vital and dyscritic; others have a gnostic element and are epicritic. But until they are more fully worked out, we shall not be able to solve the problem of nystagmus, or many of the other problems involved in the interpretation of some of the more difficult forms of ocular palsies and ocular disturbances.

Delegates from the United States, France, Holland, Spain, Italy, Norway, Sweden, Austria and Belgium voiced sincere congratulations to the society on the attainment of its jubilee, and presented an ivory presidential mallet, suitably inscribed in enamel.

THE HARDERIAN GLAND-XEROPHTHALMIA, VITAMIN A DEFICIENCY, KERATOMALACIA. MR. E. TREACHER COLLINS.

Deductions from the detailed evidence brought forward are as follows: 1. The eyelids and para-ocular glands have been developed in animals living in an aerial environment to protect their eyes from foreign substances, and to prevent their corneal epithelium from undergoing keratinization. 2. The lacrimal secretion acts mainly as an irrigating antibactericidal fluid. 3. The mucous secretion of the harderian gland preserves the corneal epithelium from keratinization in those animals in which it is present. 4. The disappearance of the harderian gland in primates is compensated for by an increased development of unicellular mucous glands (or goblet cells) in the retrotarsal folds the ocular conjunctivae. 5. In animals fed on a diet deficient in vitamin A, the harderian glands soon become atrophied and cease to function. In the absence of their secretion the epithelium of the cornea and conjunctiva undergoes keratinization. 6. This keratinization may involve the ducts of the lacrimal and meibomian glands so that they become secondarily involved. 7. In human beings whose diet is deficient in vitamin A, the mucous secreting cells of the conjunctiva atrophy and cease to function, so that keratinization of its epithelium takes place. 8. In the absence of its mucous secretion, the surface tension of the conjunctiva becomes altered so that the fatty secretion of the meibomian glands adheres to it. 9. This fatty secretion forms an excellent pabulum for micro-organisms to grow in, both pathogenic and nonpathogenic, the former excites an inflammatory reaction, which, in the cornea, results in keratomalacia. 10. As the absence of vitamin A from the diet gives rise to changes in the mucous membranes of other parts of the body, similar in character to those produced in the conjunctiva, further investigation is desirable

to determine whether they may not also be attributed to want of hydration from a deficiency of mucin. 11. Inability to see in dim light after exposure to bright light, which is a symptom frequently met with in association with xerophthalmia, has been produced in rats by a diet deficient in vitamin A and found to be accompanied by a marked delay in the regeneration of the visual purple (Ejler Holm). 12. Xerophthalmia is frequently accompanied by pigmentation of the conjunctiva in the dark-skinned races of man and animals. Such hyperpigmentation in animals is due to an exaggeration of the normal pigmentation (melanin), and in this respect resembles hyperpigmentation of the skin in Addison's disease. 13. One per cent aqueous solution of mucin, suitable for application to the eye can be prepared from the desiccated harderian glands of sheep by the use of sodium hydroxide.

SOME CASES OF DAMAGE TO DESCEMET'S ENDOTHELIUM. MR. FRANK JULER.

The contribution consisted of some of the author's experiences in support of the following dicta of Friedenwald in his recent book on the pathology of the eye: "The influence of Descemet's membrane on the nutrition of the cornea is entirely unknown, for the membrane and the lining endothelium combine to form a barrier against the passage of fluid and of substances in solution, from the anterior chamber into the cornea. When the endothelium is injured, the barrier becomes imperfect and œdema of the cornea results, which manifests itself (1) in the formation of blebs under the epithelium, (2) in a general milky haze of the cornea, (3) in the development of folds in Descemet's membrane." These experiences of Mr. Juler could be grouped as follows: (1) edema of the cornea from a fragment of glass free in the anterior chamber, (2) corneal opacity resulting from irrigation of the anterior chamber in process of cataract extraction, and (3) epithelial dystrophy of the cornea in two sisters. The cases are related in detail.

In regard to the second of these, irrigation of anterior chamber, the dangers of irrigation (apart from possible infection, were loss of vitreous, and the use of solutions of incorrect concentration or irritant action) would appear to lie in using the solutions too hot or under too great pressure, or in damaging the back of the cornea with the nozzle of the irrigator, the latter being an especial danger when there was recent damage to the endothelium.

NEW OBSERVATIONS ON THE PHYSIOLOGIC ACTION OF THE EXTRA-OCULAR MUSCLES. MR. DUKE-ELDER.

The author outlined experimental work demonstrating the effect of choline and acetylcholine on the extrinsic muscles of the eye. The matter arose during research on the effect of various drugs on the intra-ocular circulation when peculiar reactions on the intra-ocular pressure were registered with choline. These were traced to a contraction of the recti and obliques which was unaffected by the administration of atropine and which was abolished by the use of nicotine and curare. It was pointed out that this reaction corresponds in every way with the phenomena described in denervated muscle of the tongue by Vulpian, and innervated skeletal muscle by Sherrington, by which a pseudomotor

contraction of this order is obtained either by the stimulation of the sensory or vasodilator nerve supply or by the injection of choline. This peculiarity in the physiologic action of the extrinsic muscles of the eye, whereby they behave in the same way as denervated voluntary muscle elsewhere, was discussed in relation to the peculiarities of the sensory innervation of these muscles with regard to the fifth nerve, and the sensory fibers in the third, fourth and sixth nerve, and also with regard to the peculiar anatomic features of the muscle fibers themselves.

Night Blindness Due to Vitamin Deficiency. Dr. W. R. Aykroyd.

Cases of functional night blindness have frequently been recorded in various parts of the world. It consists in a temporary, often recurrent, difficulty in adaptation, and for several reasons has been thought to be due to vitamin deficiency. It is rapidly curable with cod liver oil, or mammalian or bird livers. Though clinical evidence points to lack of vitamin A as the cause of functional night blindness, the etiology of the disease can not yet be said to be established beyond question. Vitamin A has been regarded as anti-infective, its absence predisposing to bacterial invasion of mucous membranes, but little has been made of its possible function in preserving retinal efficiency.

During the previous summer the author made observations in Newfoundland and Labrador with the view of ascertaining whether the condition was unquestionably due to vitamin A deficiency. The diets of the patients in a series of cases of hemeralopia were found to be obviously deficient in vitamin A. In some cases the disease developed in less than a month after the patient was put on the deficient diet. This diet contained no milk, eggs, butter or green vegetables. One patient had learned that dark glasses protected him from the disease, so covering one eye up by day ensured the use of one eye for night. One or two doses of cod liver oil cured the condition in from twenty-four to forty-eight hours. Exposure to strong sunlight also played a part; this was true of the Labrador fishermen, who spent a large part of each day in open boats. Still, the disease did not occur in the normal person on a diet of ordinary food, however strongly he might be exposed to sunlight. In women the disease was usually associated with pregnancy, and then, when untreated, it tended to clear up spontaneously. Delay in the regeneration of the visual purple, which Fredericia and Holm showed to occur in vitamin A starved rats, accounted for the observed clinical facts. In the normal eye the central parts of the retina were sufficiently sensitive, when adapted to the dark, to be stimulated by ordinary twilight or night illuminations. In the eye in which regeneration of visual purple was deficient or delayed, similar illuminations were too weak to stimulate the central parts of the retina, but might rise above the lower threshold of the periphery. For this form of night blindness the term "dysskotopia" or "nutritional dysskotopia" was suggested.

Oculomotor Palsies Resulting from Infective and Toxic Processes. Dr. James Collier.

The author referred to such toxic processes as diphtheria, polyneuritis, botulism and veronal intoxication, and to the ocular paralysis occurring in myasthenia gravis, of which the pathology is not yet known.

Some admirable experimental work had recently been published which had a profound bearing on this subject. He first submitted a simple division of the patterns of oculomotor paralysis as met with clinically. First there was the peripheral paralysis, which was in terms of the distribution of the peripheral oculomotor nerve or one of its branches. The second was the supranuclear paralysis, which was in terms of the physiologic use of the eyes. In this form, diplopia did not occur, and this variety was associated with either marked widening or narrowing of the palpebral apertures, but never with complete ptosis. Third, there was the nuclear paralysis, which was characterized by its irregularity, by the condition of both eyes, by the constant loss of parallelism and diplopia, and by the presence of nystagmus. Often it seemed to be a kind of blend between a supranuclear paralysis and a peripheral nerve paralysis. Fourth, there was the paralysis resulting from the specific selective activity of a poison on a particular physiologic mechanism. Dr. Collier discussed each kind, and related illustrative cases which he had had.

TRANSPLANTATION OF THE CORNEA. MR. J. W. TUDOR THOMAS.

Four rabbits were exhibited in which the author had succeeded in producing clear corneal grafts. He said that transplantation of corneal tissue was first attempted 107 years ago, but, so far, no really satisfactory operative procedure had been established. His sixth method, the most successful of the methods tried consisted of the taking of a graft from the margin of the cornea of triangular or quadrilateral shape and uniting it to the cornea by cross-stitches, a wide iridectomy being performed so as to prevent the iris from adhering to the graft. Fourteen rabbits were operated on in this way. In thirteen of them the grafts became united. Two were transparent at three and four months, respectively. He said that the grafts must be manipulated with great care, and must not be grasped by forceps or other instruments. Olive oil should be used to lubricate any instrument which might come in contact with the graft, and the latter should be placed in sterile olive oil before placing it in the gap prepared for its reception. The margins of the graft should be cut in a shelving manner. Partial detachment produced opacity, which usually affected the whole graft, as also did adhesion between the iris and the graft. Cross-stitching seemed to overcome most of the difficulties. He proposed to continue this work. He would not try the method on a human being until he had obtained more exact information from his experiments on rabbits.

THE BOWMAN LECTURE. SIR ARTHUR KEITH.

Sir Arthur introduced his subject by relating an incident which gave an intimate view of Sir William Bowman's personality. James Syme, when Regius Professor of Clinical Surgery at Edinburgh had, in 1857, publicly condemned the operation of iridectomy for relief from acute glaucoma, and Bowman wrote him a personal letter stating that he found it the only certain and indispensable treatment for the condition. He did not "rush into print," though eventually Syme sent the correspondence to the *British Medical Journal*, in which his attack on the operation had appeared. Following this, Sir Arthur had much to say on the

importance of personality. In his youth, Bowman made brilliant discoveries in anatomy, and in his full tide he did more than any other man in the domain of ophthalmology. Those who knew him would not ascribe his ascendancy to the iridescence which shone in life and died with a man; his was of finer and sterner stuff.

Before he was 25, Bowman had advanced medicine by a series of notable discoveries; he had rare gifts of mind, and he must have had some missionary quality which urged him on. It was an urgent desire for betterment which probably explained his distinction, yet only rarely could one obtain a glimpse of his motives. The master and inspirer of Bowman was Professor Robert Bentley Todd, Bowman's senior by only seven years, and with him Bowman shared the chair of anatomy and physiology. Bowman was never tired of extolling Todd's excellence in heart and life. The discovery of the improved compound microscope marked a definite epoch in anatomic and physiologic discovery, and many of these the lecturer particularized. At the age of 25, Bowman was elected a Fellow of the Royal Society, for his paper on the structure of muscle, ,and in 1841 he received the Royal Medal for a paper on the structure of the kidney. Sir Arthur considered that Bowman made a larger contribution to our knowledge of the anatomy of the eye than any other investigator; he also made important discoveries in the ear, and our conception of the basilar membrane was due to him. He made surprisingly few mistakes.

Sir Arthur touched interestingly on what he termed an enigma in Sir William Bowman's life. From his 22d to his 26th year investigations and discoveries followed each other regularly, and then his ardor for discovery seemed to have cooled, though he still added to the resources of medicine and surgery; still, the last fifty years did not fulfil the promise of his earlier ones. An event of significance at this time was that in 1842 he was happily married. The lecturer speculated on what might have happened had Bowman, in the full tide of his discoveries been appointed surgeon to King's College Hospital in place of Sir William Fergusson.

In the course of a fascinating parallel between Lister and Bowman, Sir Arthur said that both those great men proved in their first publications that they were not apprentices, but master workmen; both became Fellows of the Royal Society; they had much in common physically, and their tastes harmonized, and both had a deeply rooted desire to help the poor and unfortunate. Also they were equally modest and unassuming. If in the turn which fate gave to Bowman's career general surgery could be said to have suffered, ophthalmic surgery certainly reaped an "exceedingly rich reward."

Discussion on Disorders of Secretion of the Endocrine Glands Associated with Diseases of the Eye.

Mr. J. H. Fisher: Diabetes has been accepted by ophthalmologists as the cause of a great variety of ocular manifestations: ophthalmoplegia externa and interna, toxic amblyopia, abnormalities in refraction, iritis, cataract and retinitis. Removal of the posterior lobe of the pituitary body results in diabetes insipidus, though it is not clear whether or not the diuresis is due to damage necessarily done to the pars tuberalis and

to the floor of the third ventricle. It is relieved by injections of posterior lobe extract, and at the same time this substance has a galactagogue effect. A deficiency in the supply of insulin from the islets of Langerhans results in disorder of the carbohydrate metabolism of the body, so that the liver and skeletal muscles fail to store up glycogen. An accelerated production of carbohydrates from protein—also probably from fats—takes place at the same time, so that dextrose appears in the urine. Proper doses of insulin would restore the balance, while an overdose causes hypoglycemia. An excess of the thyroid hormone stimulates adrenal function, but the immediate effect of thyroxin is to diminish the animal's sugar tolerance. Atrophy or excision of the thyroid gland, as of the anterior lobe of the pituitary, increases the sugar tolerance of the body. I wonder whether, in mild cases, the ophthalmic surgeon has a conception of the perverted processes which are responsible for the appearance of the detected dextrose. He needs to know more about the case: whether, for instance, it is a case of pancreatic incompetence—possibly from malignant disease—with a hyperglycemia. If no dextrose is found in the urine, possibly an atrophy of the thyroid gland, or a diminished secretion from the anterior lobe of the pituitary, by increasing the sugar tolerance, is disguising the condition. I should like the assistance of physicians and biochemists in this discussion. It would be wise to seek a physician's advice as to the best moment for performing a cataract extraction on a glycosuric patient. Dr. Cammidge's observation that retinal hemorrhages are due to a low calcium content in the blood is valuable, as administration of calcium lactate is obviously the treatment. Myasthenia gravis has been described as associated with hyperplasia of the thymus, congestive enlargement of the parathyroids, and with exophthalmic goiter. Thyroid extract has been used in its treatment. I also wish to refer to cases of myotonia atrophica with familial cataract, for which a metabolic disturbance has been suggested. There are also cases of pigmentary degeneration of the retina associated with polydactylism, which have been associated with hypopituitarism. Fields of vision similar to these during pregnancy have been demonstrated in women who have undergone double oophorectomy. The hyperthyroidism of exophthalmic goiter is commonly accompanied by amenorrhea. The endocrine glands are factories, each turning out its special product which is essential not only to health but to life, and the perpetuation of the species. This raw material reaches each of the factories in the blood stream. I suggest that in cases of endocrine disorder the biochemists investigate to the utmost the constitution of the blood, from which alone the ductless glands draw their pabulum and into which they pour their products; it might be that in this direction would be found the solution of many of the most fascinating problems.

PROFESSOR H. MACLEAN: I shall deal with the subject from the medical side, practically confining my remarks to glycosuria. It is in the type of case in which glycosuria is associated with difficulty of storage by the liver that the majority of retinal lesions occur. Sometimes the eyes are affected when the patient appears to be in perfect health, and it is then difficult to get consent to use insulin because there is some slight retinal difficulty. Since the introduction of treatment with

insulin, there is no more risk in operating on a diabetic patient than if there were no glycosuria present.

PROFESSOR DODDS: I find the standard textbooks difficult to understand on the question of cataract, as many statements are made in this connection which cannot be followed by the biochemist. I have a suggestion which, if followed, might clear up many doubts, namely, that a biochemist should be included on the staffs of ophthalmic hospitals.

The discussion was continued by Mr. A. W. Ormond, Mr. C. Goulden and Prof. Meller (Vienna), and the openers replied.

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TARSAL BIOMICROSCOPY OF SOME FORMS OF CONJUNCTIVITIS. DR. CUENOD AND DR. ROGER NATAF, Tunis, Tunisia.

Specimens of normal and hyperemic conjunctiva were shown; also this tissue after infection by Koch-Weeks' bacillus. At the outset, one notes a neovascularization perpendicular to the normal. Later, there is a sort of parquet pattern of small, sharply outlined patches, less organized and perfect, i. e., more rudimentary, than in pure trachoma. These papillae are probably separated by a lymph circle superimposed on the normal vascular circle, of which it is the homologue. In "follicular" conjunctivitis biomicroscopy failed to reveal any follicles. There are papillae, more or less modified, in which the vascular elements determine the structure of the papilla, more or less hypertrophied by small cell infiltration. Spring catarrh showed a striking picture. The vegetations are formed by polypoid growths on the surface of which one finds, well marked, the parquet or mosaic seen between the vegetations. These are composed of groups of papillae raised up "en bloc" by proliferation of the underlying fibrous tissue.

PROPHYLAXIS OF OPHTHALMIA NEONATORUM. PROFESSOR VAN DER STRATEN, Louvain, Belgium.

Crédé's method dates from 1879; the description was first published in 1881. At first, he tried out disinfection of the genital tract in gonorrhea of the mother. Not satisfied with the results, he proceeded to instill one drop of silver nitrate, 2 per cent, into the previously cleansed eyes of the newly born infant. The results were far beyond expectation. Crédé then devoted himself to proving that this preventive instillation was the sole factor of cure. Complete prophylaxis still requires disinfection of the genital tract of the mother. This and the preliminary cleansing of the conjunctival sac, lids and surroundings of the infant must not be neglected. Physicians have come to put exclusive trust in the silver nitrate, and this is a mistake.

AN EPIDEMIC OF ACUTE FOLLICULAR CONJUNCTIVITIS. DR. TOULANT, Algiers, Algeria.

The condition was of an unusual type, starting apparently as ordinary acute conjunctivitis. Soon, however, follicles appeared on the upper tarsal conjunctiva, with marked infiltration of the lid, ptosis and preauricular adenitis. The cornea did not ulcerate, but the superficial epithelium invariably showed a slight desquamation with marked lacrimation, photophobia and intolerance of collyria. The disease was mildly contagious and often remained limited to one eye, healing completely and without scar formation in two or three months. Bacteriologic examinations yielded negative results, and no cell inclusions were found in scrapings of the tarsal epithelium

KERATITIS WITH FLEETING MANIFESTATIONS. DR. LEMOINE AND DR. VALOIS, Nevers, France.

The condition developed suddenly with marked pain, lacrimation and photophobia. There was slight redness of the conjunctiva but no visible corneal changes. In from six to twelve hours the pain lessened, and recovery took place in two days. Biomicroscopic examination after instillation of fluorescein showed a number of small dotted denudations of the epithelium of the central zone of the cornea. After forty-eight hours the cornea again presented its normal appearance.

MENSTRUAL EPISCLERITIS. DR. VILLARD, Montpellier, France.

A woman, aged 42, in good general health, with residua of chronic metritis, had had attacks of episcleritis of moderate severity in the left eye, with each period for five years. The scleral inflammation came on about eight days before menstruation, reached its maximum with the appearance of the flow, and disappeared with its cessation. A peculiar feature was noted in that the attack of episcleritis was regularly checked by the removal of a small amount of blood eight days before menstruation. The preventive effect of this minimal removal of blood was discovered by chance in taking blood for a Bordet-Wassermann test. It had been striking and invariable for two years.

THE RÔLE OF THE IRIS ANGLE IN OCULAR HYDROSTATICS. DR. M. TEULIERES AND DR. J. BEAUVIEUX, Bordeaux, France.

Intraocular tension depends on two factors: the mass of blood circulating in the interior of the eye and that of aqueous. The latter has no continuous flow when the eye is at rest but in the dynamic state the channels of excretion, and particularly the filtration angle and the canal of Schlemm, play a part. This is shown, anatomically, by the structure of the iris angle in the fetus, in man and in the animal series. Photomicrographs show a grill structure of the pectinate ligament and a relation of Schlemm's canal with the spaces of this ligament and the scleral veins. Experimental ophthalmomalacia and injections of india ink or colored solutions into the eye show the passage of these materials into the pectinate ligament, the canal of Schlemm and the scleral veins, and explain the passage of the aqueous forward and its

exit by the canal. Too rapid filtration meets with obstacles at the chamber angle and hypertension by retention follows. Hypertension by end-ocular obstacles or of afferent paths of the venous system of the anterior segment is found in pupillary obstruction, pathologic products in the anterior chamber, congenital absence of the iris angle, tumor of the posterior segment of the globe and Knies' adhesions. Extra-ocular obstacles or those of the efferent channels are caused by caustic burns of the conjunctiva and cornea, xerosis in trachoma, lesions of roentgen therapy and tumor of the anterior segment. All this indicates gradual osmotic filtration rather than an actual current, renewing and purifying the aqueous humor, in the healthy eye.

Study of the Dilatator Pupillae. Dr. E. Redslob, Strasbourg, France.

In the human, mammalian, avian and piscine eye, the layer of Henle is a myo-epithelial layer arising from the anterior epithelium of the iris. In the chick, the dilatator muscle of the iris is composed of variably striped muscle fibers of exclusive mesodermal origin, disposed radially to the contact with the anterior neuro-epithelial layer. It is separated from the epithelium by a well marked limiting membrane, but this has no analogy with the membrane of Bruch-Henle. The anterior epithelial layer is incapable of elaborating muscular tissue elements, as it degenerates almost completely over most of its extent (sic, P. H. F.). So that if the dilatator muscle in the chick has no morphologic relation with the underlying epithelium, it is essentially different from this muscle as it presents in mammalians.

Rôle of Traumatism in Certain Forms of Iritis. Dr. M. Fage, Amiens, France.

Diatheses and morbid conditions may act as factors in injury, and produce iritis with special characteristics. From the medicolegal point of view, it is difficult to count on previous pathologic conditions of the subject, as the law does not consider antecedent conditions. Still, in court, it would be well to note such conditions and leave it to the judge to admit or refuse this evidence. Knowledge of these factors will always be useful to the physician, and it is of practical importance in the diagnosis, prognosis and treatment.

Relapsing Iritis in Familial Hemophilia. Dr. Jean-Sedan, Marseilles, France.

A patient with pure maternal hereditary hemophilia of the mendelian type, presented short, acute attacks of iritis with massive hematoma (sic, P. H. F.) on three occasions, following bleeding. The iritis invariably appeared about the tenth day and was favorably affected by injections of antidiphtheritic serum administered to counteract the hemophilia. On one occasion the iritis occurred after a simple "hematoma" without any "cutaneous erosion," thus excluding the possibility of external infection. There was never an infection of the hematoma. Neither the patient nor his five brothers and sisters were syphilitic, nor was he tuberculous or rheumatic, although like all

patients with hemophilia he had had attacks of arthritis after hemorrhagic effusions into a joint. It is certain that the antidiphtheritic serum had nothing to do with the iritis, as the latter appeared, in one instance, before serotherapy. Blood absorption in the region of the hematoma is considered the causal factor. The blood serum, separated from the endothelium of the blood vessel, undergoes physical and colloidal chemical changes and becomes toxic, producing inflammation of the iris.

MEDICAL AND SURGICAL INDICATIONS IN TORPID IRIDOCYCLITIS AND TUBERCULOSIS. DR. ONFRAY, DR. PLICQUE AND DR. DUCLOS, Paris, France.

The notion of a filtrable virus seems to extend to the domain of ocular tuberculosis. Nine patients with tuberculous iridocyclitis were treated with methylated antigen according to Bocquet and Nègre. In eight cases the result was good, but treatment was prolonged, and in three cases surgical measures were required to reduce intra-ocular tension. Elliot's operation was performed with good results in two cases of serous iritis with plus tension. Antiglaucomatous iridectomy was required in one case of plastic iritis. There was complete failure of treatment in only one of these nine cases, in which nodular iritis occurred, requiring enucleation.

A CASE OF SCROFULOUS IRITIS CURED BY SPLENOTHERAPY. DR. FRADKINE, Autun, China.

A young man with a hereditary and personal tuberculous taint had inflammatory iritis of Poncet type (sic, P. H. F.) in the right eye; nodular, exudative iritis appeared in the left eye several months later. The "scrofulous" facies of the patient indicated an allergic, immunized state, allowing a benign evolution of the iritic process like Koch's phenomenon. The term scrofulous iritis in the sense of allergic is accordingly fully justified. Splenotherapy gave rapid and excellent results in this case of typical scrofulous iritis, i. e., with massive fibrinous exudate and a solitary nodule, without involvement of Descemet's membrane. It should be tried before any other general treatment.

PENETRATING WOUND OF THE GLOBE; CILIARY PROLAPSE; COMPLETE RECOVERY UNDER A CONJUNCTIVAL FLAP. DR. H. TRUC AND DR. H. DEJEAN, Montpellier, France.

A contused wound of the eye by a large splinter of glass occurred, due to the bursting of a bottle of lemon soda and probably without intra-ocular retention of a foreign body. A flap-shaped scleral wound, from 5 to 6 mm. from the limbus at 3 o'clock, was seen, with a hernia of the ciliary body as large as a pea, of twenty-four hours' standing. The serious nature of the injury suggested the necessity of enucleation, but reposition of the prolapsed ciliary body and its protection with a conjunctival flap without scleral suture resulted in complete recovery with normal vision. This therapeutic success to the credit side of conservative methods proves the value of protective conjunctival flaps even in cases that at first appear desperate.

SLIT-LAMP STUDY OF THE NORMAL AND PATHOLOGIC LENS. DR. DUVERGER, Limoges, France, AND DR. VELTER, Paris, France.

The importance of correlating data of biomicroscopy with those of other methods of examination, notably the histologic, is noted. This, of course, is not feasible in the case of the transparent lens. The slit-lamp decides absolutely the question of the presence or absence of the lens. With focal illumination, zones of discontinuity can be distinguished in the thickness of the lens, so that the latter may be divided topographically into concentric layers in accordance with structure and progressive development in life. This allows one to draw conclusions as to both the location and the age of changes found. Anterior embryonic remains (persistent pupillary membrane? P. H. F.) can be differentiated from inflammatory products; otherwise, this is a diagnostic procedure of doubtful accuracy. Posterior embryonic remains can be noted, and our knowledge of the appearance and frequency of these anomalies greatly increased. With high magnification, it is almost impossible to find a lens without some opacities, large or small, and sometimes of various colors. This is important practically, and shows that opacity of various kinds and ages does not necessarily mean cataract but often remains stationary. Repeated examinations throw light on the question of progression. There are constant senile changes without significance as to cataract, e. g., internal dispersion and amber or yellow color, already known. The slit-lamp adds: increase in the number and distinctness of zones of discontinuity, the increased modeling of the nucleus, increased number of spherules in the shagreen (mosaic of anterior lens capsule epithelium), marked distinctness of the anterior sutural lines of the lens-star figure, and its "punctuations." Age-changes suggesting progressive cataract formation include the well known appearances of subcapsular vacuoles and of clear spaces or clefts in the cortex. The slit-lamp has shown these changes to be more common and less serious, prognostically, than was formerly believed, and it has added the more significant feature of lamellar dissociation. It also allows one to differentiate between senile, traumatic and choroidal forms; it at once decides definitely the degree of maturity, and throws needed light on obscure forms of secondary cataract hardly visible with other methods. The slit-lamp furnishes many useful clinical details, but not a new pathology. It presents old conditions under a new light, with other hitherto undiscovered details, and adds greatly to the means of prognosis. The observations should always be compared with the results of other methods of examination if one wishes to avoid erroneous interpretations.

BIOMICROSCOPY OF CATARACTA NIGRA. DR. MAWAS, Paris, France.

This senile form is not due to imbibition of pigment, as is generally believed, and the lens is not flocculated as are most senile cataracts. Only the capsule or at best the immediately underlying lens layers show one or more points of flocculation. The gray shadows of these points are thrown on the nucleus as dark conical areas. There is thickening and increased volume of the embryonic and adult nucleus. A remarkable phenomenon is the splitting up of the light beam at the level of the nucleus. The latter appears light yellow at the periphery, slightly orange

in the anterior third, and then red, reddish brown, and dark brown, in the depth. The lens appears to decompose light and absorb violet, green and blue rays, allowing only light of long wave length to be reflected. The histologic and microspectroscopic study of sections confirm the slit-lamp observations. The lens retains its "anotomic integrity" and there is merely a change, viz., an increase, in certain physical qualities, such as refraction index, volume, density and color.

SLIT-LAMP STUDY OF HEREDITARY AND FAMILIAL CATARACT. DR. P. VEIL AND DR. A. FAVORY, Paris, France.

Changes in the lens, all of the same biomicroscopic type, occurred in five successive generations. An opacity was uniformly observed, situated principally behind the fetal nucleus and extending toward, but not quite reaching, the "posterior cristalloid." It had a stratified structure of nummular appearance, and was surrounded by a hazy ("poussiereux") zone. The rest of the lens was clear. These cataracts seem to belong in the category of a dominant mendelian factor. The heredity is direct, continuous and similar; transmission is by feminine filiation, but involves the offspring without distinction of sex. This disease could not be traced to any obvious pathologic factor, and heredosyphilis as well as endocrine anomalies were positively excluded.

BIOMICROSCOPY OF ENDOCRINE CATARACTS. DR. WEILL AND DR. NORDMANN, Strasbourg, France.

The development of this form is always superficial. It is not possible to group cataracts according to etiologic principles, so for the present we distinguish, morphologically, a form with posterior "saucer-like" opacity and a dotted or flaky cataract. In the former, one may distinguish between the diabetic and the tetanic variety, by noting that accentuation of the outline of the fibers between the vacuoles is one of the earmarks of the latter dyscrinism. The close relationship between these cataracts and senile cataracts of the same name (sic, P. H. F.) is undoubted. In the second group with dotted or flaky opacities a definite diagnosis is impossible, partly on account of the insufficient number of clinical observations and partly because two syndromes are too similar, e. g., tetany and myotonia, both of which depend on or are associated with decided lack of calcium.

GLASS-BLOWERS' (VERRIERS) CATARACT. DR. BADOT, Jumet, Austria.

Exposure of the eyes to heat and intense light result in the course of years in a diminution of sight and often in an occupational cataract, which may be direct or indirect. It was found in from 18 to 20 per cent of glass-blowers. Of these, 5 per cent were below 40 years of age; 45 per cent were from 40 to 60 and 52 per cent from 60 to 80. At first, this glass-blowers' cataract is a posterior polar or posterior cortical type, later posterior subcortical and finally total. Dark glasses, of smoke or various gray shades, are of preventive value. The question of occupational prophylaxis will soon be academic, on account of the almost complete "mechanization" of the glass-blowing industry.

THE INCISION OF CHOICE IN OPERATION FOR SENILE CATARACT. DR. E. JUNÊS, Sfax, Tunisia.

Use systematically a vertical "flap" (sic, P. H. F.), with a base corresponding to the vertical diameter of the cornea and a periphery in the limbus. This is effected by median puncture with a keratome, enlarged on both sides by perpendicular incision with scissors. This is a revival of Daviel's method, except that the incision is perpendicular instead of horizontal, and is made almost entirely with scissors instead of mainly with the lance knife. This technic explains the advantages of the modified method, especially, ease and security of performance. This allows uniformity of procedure in operations on the lens; the first step, corneal puncture, represents the linear incision applied to soft cataracts and generally placed in the lateral sector (?P. H. F.) of the cornea.

OCULAR OPERATIONS WITH TWO NEEDLES; PRACTICE AND PROCEDURE. DR. AUBARET, Marseilles, France.

The use of two needles should be generalized and extended to new fields of ophthalmic technic, and is an excellent form of operative training. In tattooing of the cornea for scars or leukoma, the introduction of india ink on two needles gives more rapid results and allows especially good double fixation of the globe, which is, so to say, harpooned, held immobile and placed in position at the will of the operator. In paracentesis and section of the globe the double opening stabilizes the outflow of aqueous, prevents prolapse of the iris and facilitates emptying, cleaning and irrigation of the anterior chamber. It is of great value in hypopyon, hyphema or secondary traumatic cataract, etc., and allows of the introduction, at the level of iris or pupil, of two opposed or associated instruments. It is comparatively easy to section almost the entire cornea with two needles and so to amputate the anterior segment of the globe. Surgical exercises with two needles are invaluable for training practice.

USE OF THE LOOP IN OPERATIONS FOR CATARACT. DR. POLLET DELILLE, Tourcoing, France.

It is generally admitted that except in case of subluxated lens the Snellen wire loop should not be used unless, vitreous having been lost, the operation has to be finished as quickly as possible. My studies show that it is possible to extract a cataract by means of the loop without loss of vitreous, that this procedure is indicated rather frequently, and that when the maneuver is performed under definitely specified conditions, it is less dangerous than traditionally admitted. I practice extraction with the loop after opening the capsule: (1) with refractory patients; the result is the loss of a small amount of vitreous in two thirds of the cases; (2) if the lens is not delivered after two or three suitable attempts at expression with the spatula; the result is loss of vitreous in one third of the cases. The instrument used was of the Snellen type, but smaller in every way. On the basis of forty cases, I wish to stress the inadvisability, even the danger, of waiting for vitreous to present or for actual loss before using the loop. On the contrary, it should be used as soon as there is evident danger of that complication, and it will often prevent and generally limit its extent.

THE VITREOUS AFTER EXTRACTION IN THE CAPSULE; CLINICAL STUDY. DR. DE ST. MARTIN, Toulouse, France.

There is no basis in fact for the objection that this operation leads to permanent changes in the vitreous and predisposes to secondary glaucoma and detachment. The author's statistics on 153 cases prove the opposite. The visual results are lasting and superior: from 8/10 to 10/10 in 72 per cent of the cases. Vitreous opacities, occurring in 15 per cent of the cases (almost always due to accidental hemorrhage), clear up and do not persist in more than 3 per cent. One case of glaucoma and one of detachment represent a very small percentage. The test of the time continues to show the great superiority of extraction in the capsule. The objections were the result of errors of observation, attributed to the operative method, accidents for which very often, the surgeon or the patient himself were responsible.

CATARACT OPERATIONS WITHOUT BANDAGING; METAL EYE-SHIELDS. DR. DE ST. MARTIN, Toulouse, France.

Many ophthalmologists welcome the suppression of the occlusive dressing after operation, whether fixed by roller bandage or by adhesive strips, but they realize that the eye must be protected from shock or pressure as well as from conjunctival infections and must be free to be opened and inspected by the surgeon. The device shown is made of a thin sheet of silvered copper, follows the outline of the orbital margin, hooks over the root of the nose and is thus held in place. It is light, agreeable to the patient and effective. These shields have done away with postoperative conjunctival reactions and with traumatic hyphema, formerly deplorably frequent.

GLAUCOMA AFTER CATARACT EXTRACTION. DR. V. MORAX, Paris, France.

This is one of the most grave and inauspicious sequelae of extraction. It may be due to subacute iridocystitis (iridocyclitis?) or also to faulty cicatrization healing of the section with obstruction of the iris angle by invagination of corneal epithelium and its invasion of the anterior chamber. Histologic examination, alone, enables one to differentiate between these two processes as etiologic factors. Lagrange's operation is the procedure of choice in these cases and should be performed as early as possible, although it is known that this operation does not give as good results in secondary as in simple chronic glaucoma. Even if this operation does not preserve sight, it will control pain and irritation of the globe if the hypertension is due to irridocystitis. In case of glaucoma due to ingrowth of corneal epithelium, these symptoms can be checked only by enucleation or, at best, by ablation of the anterior segment of the globe.

PSEUDO-GLAUCOMA. DR. AUBINEAU, Nantes, France.

As de Wecker believed and Morax (1916) reaffirmed, it seems that there really is optic atrophy with a cupping distinct from glaucomatous excavation. In two cases observed, repeated tonometric examination at different hours failed to reveal any rise in tension. In one patient there

was hypotony with a syndrome of lowered blood pressure. In glaucoma, vision has already been decidedly lowered at the time that an excavation is noted, while in "atrophy with excavation" there may be decided recession of the lamina or cupping without any marked loss of vision. This is an important factor in differential diagnosis. Increased intraocular tension is the indispensable feature of glaucoma, and the one which alone justifies operation.

SEMICORNEAL TREPHINE WITH IRIDECTOMY IN CHRONIC GLAUCOMA. DR. A. ROCHOU-DUVIGNEAUD, Paris, France.

Early operation by this method will preserve vision, and late intervention will save what is left of it. I trephine well forward under the conjunctival insertion in the cornea (sic, P. H. F.), with physostigmine miosis to reduce to a minimum the danger of prolapse of the iris. The procedure thus performed leaves hardly a trace.

ELECTRONIZATION OF OCULAR MEDIA. DR. BORDEAUX, Évreux, France.

Endo-electrogenesis is an internal electrification produced by having a current circulate around the globe, the latter being at the negative pole and the current going hence to the positive pole outside. This produces an outward-bound ionization and consequently (? P. H. F.) an increased excretion principally of solid or cellular elements of the endocular lymph. Later, there is a return current and a reestablishment of molecular pressure and ion-equilibrium due to fresh elements that have probably been brought in by the blood stream. Endo-electrogenesis in acute inflammations has an immediate and remarkable analgesic action. Besides, it increases the effective action of ocular medicaments, such as miotics, in a striking manner. Finally, the direct action on the structure of the media produces favorable effects in the course of acute intraocular diseases—glaucoma, chorioretinitis, iritis—as well as in such chronic disturbances as cataract, hyalitis and serous uveitis.

PERSISTENT HYALOID ARTERY AND CANAL OF CLOQUET. DR. C. DEJEAN, Montpellier, France.

Slit-lamp examinations show this condition to be usual and that the anterior insertion of the canal is nothing more nor less than the postlenticular space containing the remnants of the embryonic or primitive vitreous. Its enveloping membrane (membrana limitans intra-vitrea) is continued forward to the ora serrata separating the vitreous from the zonule and holding it in place after total (intracapsular) extraction of the lens. It is made up of a greatly densified (sic, P. H. F.) layer or membrane of the vitreous which is luminous under the slit-lamp.

DIRECT EXTRACTION OF FOREIGN BODY AT THE MACULA. DR. SEXE, Besançon, France.

I was able (1915) to extract a small bit of metal fixed at the posterior pole, under ophthalmoscopic control (upright image) in the dark-room, using the "serretelle" of Desmarres. The form of the eye was preserved and enucleation avoided. This procedure requires conditions which are rarely present: perfectly transparent media, a non-

magnetic foreign body, such as copper or stone, or possibly intra-ocular *Cysticercus*. Cocaine anesthesia must be of short duration to avoid haze of the corneal epithelium, and the operator must not be surprised at the "impressive" appearance of the stem of the forceps in full view in the vitreous and greatly magnified by the crystalline lens.

SUBJECTIVE STUDY OF THE RETINAL CAPILLARY CIRCULATION. DR. J. DUBAR AND DR. A. LAMACHE, Paris, France.

Using a modification of Fortin's entopic apparatus, we were able to analyze the vasomotor effect of various psychophysiologic and neuro-vegetative reactions, the effect of drugs and that of habitual "petty poisons" such as alcohol, tobacco and coffee. Retinal reactions may, at least qualitatively, give one an idea of the vasomotor response in the brain.

BLOOD PRESSURE OF ARTERIA CENTRALIS RETINAE. DR. FRITZ, Mons, France.

The difference between the degree of compression of the globe necessary to cause the appearance of the first sign of arterial pulsation, on the one hand, and that which causes complete obliteration of the vessel in diastole measures the resistance of the vessel to obliteration, i. e., its rigidity. With Bailliart's dynamometer, this is always less than 10 Gm. in normal subjects. In arteriosclerosis, whether or not accompanied by hypertension, this figure is exceeded.

DETACHMENT OF THE VITREOUS. DR. MARC AMSLER, Lausanne, Switzerland.

Methodical and minute, not to say meticulous, exploration of the vitreous in cases of retinal detachment, high myopia and senile changes will often reveal a fine annular ring-shaped mist or opacity immediately in front of the disk, with a central, generally nearly circular, "window." This ring represents the posterior insertion of the hyaloid torn loose from the rim of the papilla and indicates a posterior detachment of the vitreous—a frequent forerunner or prodromal sign of retinal detachment. Vitreous detachment seen in enucleated globes is not an artefact. It occurs intra-vitam, as proved by the morphology of the cauterization scars produced by Gonin's deep ignipuncture. The cautery point does not always reach the retracted and detached vitreous.

RETINAL DISINSERTIONS. DR. J. GONIN, Lausanne, Swizerland.

This term is applied to a type of retinal tears which do not take place "in the open" in retinal tissue, but result from a break in the peripheral attachment of that membrane at the ora serrata. Tears in this location easily escape ophthalmoscopic observation, but their early detection is most important, as they have a marked tendency to spread and as the detachment which they cause offers particularly unfavorable conditions for an operative cure. The gap produced by a "disinsertion" cannot be closed like a simple tear by cautery puncture. Progressive tearing has to be prevented by a line of cautery scars which cannot (?P. H. F.) bring

about perfect anatomic reattachment. This form of peripheral separation and detachment is particularly common in young subjects without high myopia and must, it seems, have a special and peculiar etiology. They are the result of a wide adhesion of the vitreous body to the retina, and probably have as a primary cause those intra-ocular effusions of blood which have been called spontaneous hemorrhages of adolescents.

Two Cases of Retinal Detachment in New-Born Infants. Dr. Paul Pesme, Bordeaux, France.

A girl, aged 8 months, had what appeared to be glioma of both eyes. Examination of one enucleated eye showed total detachment with massive exudate (blood) into the subretinal tissues and hemorrhagic retinitis. The father of this child was tuberculous with positive sputums. The infant presented the ocular complications after it had recovered from an attack of meningitis. In the second case, in a boy, aged 9 months, the ophthalmoscopic diagnosis was bilateral detachment of the retina. Death occurred from meningitis fifteen days later. The infant had suspicious tuberculous antecedents. I think that there is some connection between these double detachments in infants under 1 year of age and the meningitis that they present, and that they are of tuberculous origin.

Spontaneous Cure of Retinal Detachment. Dr. C. Pascheff, Sofia, Bulgaria.

Several cases were studied, showing the detachment of pregnancy, detachment in sympathetic ophthalmia, orbital cellulitis and high myopia and the macular form. The greater part of such cases are caused by an exudation, inflammatory or circulatory (sic, P. H. F.), of the choroid, without discoverable retinal tear, and heal without puncture or cauterization, as proved by observation for years after reattachment. Some of them showed small peripheral foci of choroiditis. I therefore conclude that these detachments are due to exudation, and that they are not associated with tears. Cure is the result of resorption and spontaneous cicatrization, and even after loss of light perception, vision may increase to 6/10, with ability to read Snellen's test type no. 1 up to 10 cm. There is more or less concentric contraction of the visual field in these cases of spontaneous reattachment.

The Clinical Course of Retinal Detachment. Dr. G. Sourdille, Nantes, France.

The fine vitreous "dust" opacity which comes on suddenly soon after detachment is not to be considered as a counterindication to operation. It is, as a matter of fact, essentially transitory, and disappears after a few days or weeks; obviously, it is not due to any deeply rooted degeneration of the vitreous, incompatible with later restitution to normal, but is a passing phenomenon possibly of a physicochemical nature, provoked by the mixing of subretinal and vitreous fluid in consequence of a retinal tear. Spontaneous detachments, wherever situated, come from an initial separation which invariably begins in the retinal "ceiling" (plafond), i. e., in the upper equatorial and preequatorial region, especially the

upper temporal. They represent an extension, generalization or migration (sic, P. H. F.) of these primary detachments with which they may be in direct connection, although in macular forms and those involving the lower segment this connection may not be apparent. This migration suggests an analogy with certain abscesses "by congestion" the more or less distant origin of which, although undoubted, is not obvious, and with Pott's disease of the spinal column, in which a cure of the primitive vertebral focus is necessary, and often sufficient, to heal the migratory abscess. So, in secondary retinal detachments it is necessary and often sufficient to cure the primary detachment, apparent or latent, which clinical observation usually permits one to locate without difficulty. Hence, always begin with puncture above or above and temporally in the region of origin. Thus certain macular or inferior detachments that appear to be independent of a primary detachment will be cured by a violent reaction produced near the latter. This also, no doubt, explains certain cures, considered paradoxic or mysterious, by puncture at a distance beyond what is now known to have been a secondary detachment. Retinal tears, whether early or late, single or multiple, are a sign of more or less definite retinal degeneration. Even if due to detachment, they may under certain conditions, be considered as sign posts indicating the original region where the curative chorioretinal reaction has mainly to be located. Variability in location or even of occurrence and of multiplicity represents a source of error against which the ophthalmologist must be on his guard.

Treatment for Spontaneous Retinal Detachment by Gonin's Method. Dr. Jeandelize and Dr. Baudot, Nancy, France.

Complete reattachment occurred in one of eight cases; in another there was complete reattachment with relapse one month later, but with improvement; in five there was evident improvement with vision from 1/10 to 4/10. One failure occurred in a patient with detachment of long standing, who was treated previously by various methods. Some retinas are very fragile, as is shown by one case in which a new tear occurred twice in the course of treatment. It is also important to treat the spots of choroiditis which one often meets with in cases of spontaneous detachment.

Operation for Retinal Detachment. Dr. R. Rubbrecht, Bruges, Belgium.

A method is described that has the double purpose of closing the tear and producing about it a focus of chorioretinitis of sufficient extent to cause a solid attachment of the retina, thus satisfying the indications given by the two opposing parties. A simple method is given to determine the meridian in which the tear is located, and in this, at a suitable distance from the cornea, a linear cauterization, of from 5 to 6 mm., is made. In this way the tear cannot be missed by the ignipuncture, even if the distance from the corneal limbus has not been calculated with absolute accuracy. Furthermore both margins of the tear are cauterized, and the inflammatory reaction extends to some distance from the site of retinal rupture, resulting in a broad and solid adhesion.

PSEUDONEPHRITIC RETINITIS IN TUMOR OF THE BRAIN. DR. COLRAT, Lyon, France.

A fundus condition closely resembling that of Bright's disease, with marked papilledema, an (incomplete) star figure at the macula and retinal hemorrhages was observed in two cases of tumor of the brain; one was verified post mortem and the other by operation. In both cases the temporal side of the macula was free from striate deposits. Kidney function was normal. A similar pseudo-albuminuric fundus is sometimes seen in optic neuritis of syphilis and of grip. It is much more rare in increased intracranial pressure due to tumor; but the fact that a definite macular star may occur without any kidney lesion suggests the advisability of thoroughly revising the traditional views as to the pathogenesis of the fundus picture hitherto accepted without question as albuminuric retinitis.

OCULAR SPARGANOSIS IN INDO-CHINA. DR. L. COLLIN, Mâcon, France.

The former director of the Ophthalmological Institute at Hué (Annam) gave clinical observations of recent date on an ocular disease that is relatively common in Annam, and that is probably widespread in the Far East. This consists of a diffuse or pseudocystic periorbital fibrosis due to the passage or encysting of the larvae (sparganum) of an intestinal parasite, *Dibothriocephalus mansoni*. The disease is characterized by diffuse swelling, chemosis, exophthalmos and limitation of ocular motility, with marked itching, pain and disturbance of vision. The results are at times serious. The location may be orbital, palpebral or subconjunctival. Treatment consists in early and radical excision of the masses of sparganum larvae. The etiology and pathology have not as yet been made clear.

INTRA-OCULAR LESIONS AND EXTRA-OCULAR (ORBITAL) FOREIGN BODIES. DR. VAN DER STRAETEN, Louvain, Belgium.

Three cases showed that (1) an extra-ocular foreign body may cause symptoms suggesting its presence in the interior of the eye; (2) roentgenography with a special capsule or shell, somewhat like an artificial eye, opaque to roentgen rays, applied to the eye, is an excellent means of localizing ocular foreign bodies, and (3) motion of a foreign body with movements of the eye does not prove an intra-ocular location. Birdshot in the orbit caused hemorrhage into the vitreous, markedly reduced vision, and fundus lesions opposite the site of the shot. Roentgenography with the shell (coque) showed that the body, which moved with the eye, was not inside the globe. Migration of the shot pellet toward the skin was seen. Extraction was done, with complete recovery. In a second case, a steel chip produced a penetrating wound of the cornea and iris, with hypopyon. Simple roentgenography indicated a foreign body in the interior of the eye, and enucleation was advised. A second roentgenogram with the opaque shell proved the foreign body to be behind and right against the globe. Recovery occurred, with vision 1/2. A penetrating wound of the cornea and iris was made by a chip of steel in a third case. Traumatic cataract resulted. Roentgenography with the shell showed a foreign body behind the globe. Infection occurred and enucleation was performed.

TREPHINE DECOMPRESSION OF THE OPTIC CANAL. DR. M. G. WORMS, Paris, France.

The following technic should be employed in inflammatory optic neuritis in which the nerve fibers are in danger of compression by inflammatory swelling of the sheaths or of the surrounding connective tissue: (1) a skin incision in the midline of the eyebrow, following the orbito-ethmoidal (sic) line, carried down to the bone; (2) removal of the upper and inner orbital wall with bone forceps, and "reclination" of the lacrimal sac; (3) elevation of the periosteum and soft parts of the orbit with the finger, following the plane of cleavage between the bony wall and the periosteum, down to the apex of the orbit; hemostasis of the anterior and posterior ethmoidal vessels; (4) breaking down of the outer wall of the last posterior ethmoidal cells with a gouge and through this breach resection of the inner wall of the optic canal in the region of its anterior segment. This is the most important step of the operation and is effected with the curet as well as with the gouge. If needed, the freeing of the canal is completed by longitudinal incision of the nerve sheath. Primary suture of the skin and soft tissues is employed with or without gauze drain. This procedure is based on exactly the same principles as decompression of the skull in increased intracranial pressure, or as that of the eyeball in glaucoma. In spite of its apparent daring, the operation is not complicated, difficult or dangerous when carried out according to the instructions given, and it has given satisfactory results in several cases. The operation is also indicated in cases of traumatic hematoma of the optic nerve sheath.

CORTICAL BLINDNESS TREATED WITH ACETYLCHOLINE. DR. ROSNOBLET, Lyon, France.

After two successive apoplectic attacks, a woman showed cortical blindness with bilateral hemianopia and associated lesions (hemiplegia, aphasia). Recovery from these lesions and restoration of the visual field, except for a right hemianopia, was noted after treatment with acetylcholine.

HALLUCINATIONS IN OPHTHALMOPATHY. DR. A. TERSON, Paris, France.

Visual hallucinations are seen often enough in those whose eyes are normal. Their appearance in the course of ocular disease is said by some authors to be due directly to chorioretinal processes. This has yet to be proved. Cases showing the following conditions were reported: alcoholism, with amblyopia and hallucinations; zonular cataract, with occasional "Lilliputian" hallucinations, the "round" of puppets ("Catherinette"); heredo-syphilis, with choroiditis, pachymeningitis and assorted hallucinations; cerebral syphilis, with complete optic atrophy; double retinal detachment, with polymorphic hallucinations coming on after blindness; tenonitis, with hallucinations noted previously. Analysis of my cases, as well as of those previously reported, shows that it is difficult, as in most sensory hallucinations, to show a direct relationship with the condition of the peripheral sense organ. If this origin were the invariable one, hallucinations would be a regular occurrence. A countless number of lesions (spontaneous, traumatic, operative) of the eye and orbit never

present this complication. Postoperative delirium and that following ophthalmoscopic examination in the dark-room are due solely to momentary confusion and disorientation (dépaysement) of feebleminded subjects. Otherwise in cases of intracranial new-growths, irritation of the optic tract, cortical (sic) or temporal lobes often causes hallucinations that may be significant for localization and operation. Without absolutely denying the ophthalmic origin of hallucinations, this is associated with an abnormal mental cerebral or psychopathic condition which would be enough to produce the same manifestations as in subjects with normal eyes, above all, in those with blindness of long standing. It is difficult to point out one exclusive, direct process, but the indirect, secondary, factor of associations of blindness with ideas and memories must certainly be admitted.

Synkinetic Sympathicofacial Blepharospasm. Dr. C. Pascheff, Sophia, Bulgaria.

In stooping, as for example to button her shoes, a woman, aged 30, began to feel as if her left eye were being drawn backward and the lids were closing. On straightening up, the blepharospasm was seen for a moment before it disappeared. I was able to elicit this phenomenon, without change of posture, by digital compression of the left cervical sympathetic. This synkinesis came on whenever the sympathetic acted.

Cancer of the Lids Extending to the Orbit and Ethmoid Sinus. Dr. G. Cousin, Paris, France.

Two cases of tubular pavement epithelium carcinoma were observed. In one, total exenteration of the orbit was performed five years ago without any application of radium. No relapse or metastasis was noted. In the second case, the lower lid was resected and radium was used to check the first recurrence. Later, total exenteration of the orbit was of no avail in preventing a fresh recurrence, and radium had a disastrous effect (? P. H. F.) as the patient finally died with the face and part of the skull invaded and destroyed by the tumor. The use of radium is therefore not justified in cancer of the lids. Surgical intervention, alone, gives lasting results.

Blepharoplasty with Cervical Flap and Tunnel Pedicle. Dr. L. Dupuy-Dutemps, Paris, France.

With this procedure I obtained a good restoration of the lids and skin of the root of the nose in a case in which no other technic would have been of any use on account of extensive and deep scars due to burn. A strip of skin extending from the mastoid to the clavicle, remaining attached at both ends, is dissected up and converted into a tube by sewing the edges together. After healing, the new blood supply which is gradually established in this skin cord loop assures independent nutrition from one or the other extremity. So the lower portion, detached and spread out, forming a living flap well nourished by its mastoid attachment, "takes" firmly and completely, although on a bed of scar tissue, to reconstruct the lower lid and a part of the cheek of the same side. Later, the mastoid end, detached and spread similarly, forms

the lower lid of the other side, the pedicle passing diagonally over the nose. The other end, anchored to the cheek by the previous graft, assures, in turn, the nutrition of the newly grafted portion. What remained of the skin rope was used to remake the integument of the back and sides of the nose. Skin transplants were used to reconstruct the upper lids, which had been less markedly disfigured.

HEMOSTASIS BY ASPIRATION IN DACRYO-CYSTO-RHINOSTOMY. DR. DE ST. MARTIN, Toulouse, France.

Time is saved and bleeding effectively checked, when epinephrine tampons fail, by continuous aspiration with the aid of a siphon of simple and strong construction. The duration of operation is greatly shortened.

EFFECT OF EXPERIMENTAL COMPRESSION ON VISION AND FIELD. DR. P. BAILLART, Paris, France.

As is well known, pressure on the globe equal to retinal systolic pressure causes sight to disappear completely in a few seconds. If only diastolic pressure is exerted, only slight clouding of vision gradually results. On the other hand, very slight pressure on the globe improves sight for an instant by compression of the retinal vein with transitory hyperemia. In glaucoma with very slight increase of intra-ocular tension, decompression operations have an opposite effect on vision. They tend to deplete the circulatory region and, by lowering vascular pressure, may arrest the flow in the capillaries where the blood current was already impeded. This explains gaps in the visual field that have been observed after antiglaucomatous operations.

VISUAL ACUITY WITH LOWERED ILLUMINATION. DR. E. HAAS, Paris, France.

Dr. Haas discussed the following points: choice of a variable; vision must be expressed as a function of intensity as this is the only photometric quantity directly perceptible by the eye; otherwise, the conditions of the test are not definite, and the figures obtained not commensurable; critical history of the methods; the mechanism and standards of measurement; Druault's candle method; Worms and Coudreux; Beyne's absorbing screens; De Haas' purely mechanical graduation; conditions of the test; sufficient and always equal adaptation; the importance and method of construction of tables of average normal vision under low illumination; interpretation of results in ametropic and diseased eyes.

REQUISITES OF A SCALE OF VISUAL ACUITY. DR. H. COPPEZ, Brussels, Belgium.

The graduation of test types should be based on the metric system like most scales and tables (industrial incapacity, admission to certain activities, refraction correction, etc.), but this scale has the disadvantage of a continuously decreasing variation from step to step, instead of a continuous progression. Scales of eight, ten or twelve steps with regular intervals are not sufficiently close together, and the values they give are too far from the decimal base. Scales of fourteen steps, on the other

hand, approximate the latter closely, and are practicable in the clinic. These scales are indispensable in measuring visual acuity in ocular disease and ametropia, and can be reduced to register loss of earning capacity and visual qualifications for admission to government service. For the former purpose, seven steps suffice: 0.1—0.15—0.2—0.3—0.4—0.5—0.6; and for the latter, a scale of six steps: 0.1—0.35—0.5—0.6—0.7—1.0. I advise standardizing regulations and admitting only these scales.

MECHANISM OF SKIASCOPY. DR. POLLIOT, Besançon, France.

The principles and physics of this procedure are poorly understood by ophthalmologists, except for a small number of specialists in optics. The understanding of this subject and of many other problems of physiologic optics is greatly aided by taking as a guide the theory of spaces of light rays which does not require a knowledge of higher mathematics and should find a place in all elementary texbooks on the subject.

ASTIGMATISM OF OBLIQUE VISION THROUGH CORRECTING LENSES. DR. M. BICHELONNE, Paris, France.

Studies with the modified fronto-phacometer of Benoist-Berthiot have proved the superiority of orthopunctal lens over the meniscus, and especially over bispherical test case lenses in oblique vision through ordinary plus and minus spheres. These studies are now extended to the usual spherocylinders and toric lenses and show that, here too, the ortho-punctals are far superior. Of course, clinical experience had proved, before these experimental tests, that refraction of the eye was not changed when the visual axis was inclined 15, 30 and 45 degrees, and so on (? P. H. F.).

ASTIGMATISM AND SPHERICAL ABERRATION. DR. M. DUFOUR, Nancy, France.

The author studied the refraction of an astigmatic pencil passing through a spherical dioptric system, applying the construction of Lissajous to equations that define the position of the focal points. After showing that approximate values for the sine, cosine and tangent of an infinitely small angle can be obtained, he proves by elementary geometry that the astigmatism is double the aberration.

DUO-FOCALS. DR. EVERINGTON, London, England.

The inconvenience and the occasional hazards of vision when looking downward through the lower segment, as in walking or going down steps are well known. My new "duo-focals" have lenses for distant vision, mounted in the usual way. Behind the frames two spherical lenses are mounted, so that they can turn on pins and cover the distance lenses, making a reading combination, at the same time allow bifocal vision. When no longer needed, these lenses turn on the pins and are folded to one side parallel to the temples of the spectacle frames. The advantages of these duofocals are that they allow good distance vision without restriction of a segment below, a good reading combination that is large

and well placed instead of low and small. They avoid the danger, inherent in bifocals of the old type, of blurring vision for distance with change of line of sight in certain directions. As presbyopia advances, the age correction with increasing strength of sphericals can be changed at slight expense and at more frequent intervals instead of discarding the complete bifocal combination.

MASKING LID DEFECTS BY SUITABLE PROSTHESIS. DR. A. BICHELONNE, Paris, France.

The careful adaptation and adjustment of artificial eyes is important. In a case observed, marked ectropion of the lower lid that was considered extremely unfavorable and difficult for operation disappeared completely after a suitable shell had been fitted.

Book Reviews

L'AMBLYOPIE CRÉPUSCULAIRE. CLASSIFICATION DE SES FORMES ÉTIOLOGIQUES. By HENRI LAGRANGE. Price, 60 francs. Pp. 180, with illustrations and 2 portraits. Paris: Gaston Doin, 1930.

The author has prefaced the clinical part of his book with a study of the physiology and pathology pertaining to the subject. He recalls the importance of the work of Parinaud, who established the rôle of the visual purple, and who was the inspiration of much subsequent investigation.

Then, from the clinical point of view, he classifies the etiologic forms of the condition.

I. MAJOR HEMERALOPIAS.

Among these, which are characterized by the magnitude of the visual impairment, are distinguished:

A. "Essential hemeralopias" (so-called), which include:

1. a hereditary type
2. an acute type

1. Hereditary type:

(*a*) Disease of Truc-Nettleship-Capion. This disease is familial, hereditary and congenital, and is a true "night blindness," vision and orientation being normal in the daytime or under artificial light and absent in diminished illumination. It is apparently localized geographically, one type being known by the name "Vendémian" (a commune near Montpellier), the other by the name Néourdes (a village midway between Toulon and Brignoles).

(*b*) Oguchi's disease. To the hemeralopia is added a characteristic appearance, a grayish milkiness of the retina. Sometimes the phenomenon of Mizuo is elicited; in that case, the fundus recovers its normal appearance on prolonged bandaging of the eyes. Histologic examination reveals alterations in the cells of the pigment epithelium.

2. Acute type:

(*a*) Bitot's disease, or "deficiency hemeralopia." To the hemeralopia is often added a bilateral xerosis, giving the characteristic "dried foam" appearance to the conjunctiva. Much more rarely keratomalacia is produced. The condition appears chiefly in the spring and attacks badly nourished subjects who have been deprived of vitamin A.

(*b*) Hepatic hemeralopia. From antiquity physicians have suspected the rôle of the liver in the production of hemeralopia. Modern authors have observed retinal diseases and difficulty in adaptation in cases of jaundice, particularly if associated with cirrhosis and cancer of the liver. In the case of a patient with hemeralopia, who died of liver disease, Boas found lesions of severe inflammation and secondary atrophy in the choroid and pigment epithelium. On the other hand, improvement has been noted in hemeralopia and xerosis following the

administration of fat-soluble vitamin A to a patient with a malignant growth in the liver. It is possible that the liver plays an important part in the epidemics of acute hemeralopia which have been described in badly nourished subjects.

(*c*) Hemeralopia in general diseases. This has been encountered in scurvy, both conditions arising from deficient nutrition, in certain infectious diseases, particularly in malaria and sometimes in typhoid fever and in the course of severe anemias during pregnancy. In certain cases of intoxication the chemicals may exert a selective action on the pigment epithelium of the retina.

B. Pigmentary degeneration of the retina. Although hereditary, this disease does not conform to any of the ordinary types of heredity. The principal signs of onset are: hemeralopia, which is early and progressive; concentric alteration of the peripheral visual field in the form of an annular scotoma, which extends toward the periphery and toward the center, reducing considerably the visual acuity; the pigmented appearance of the retina, and the yellowish discoloration of the disk. Sometimes there is a "retinitis pigmentosa sine pigmento." This disease commences in early life, and its course is progressive. From the point of view of etiology, the rôle of heredity and consanguinity is important. It has been possible to trace the hereditary factor back through several generations. It attacks both males and females, and it may attack several members of the same family. It is often associated with deafness, mental deficiency and epilepsy.

C. Intermediary forms. There is apparently a type intermediate between acquired hemeralopia and pigmentary degeneration. Hemeralopia has been found combined with rarefaction of retinal pigment, and with pigmentary chorioretinitis co-existing with annular scotomas. In one case an acquired hemeralopia appeared fifteen years before the typical ophthalmic signs of pigmentary degeneration.

II. MINOR HEMERALOPIAS.

These may appear in the course of a great number of ocular conditions:

A. Hemeralopia in ametropia. This condition obtains especially in myopes, and apparently is directly proportionate to the amount of myopia. It is encountered in 33 per cent of cases. Explanations of the phenomenon are still hypothetic. It is much less frequent in the other ametropias, and appears only when the visual acuity is far below normal.

B. Hemeralopia in monocular amblyopia and in patients with one eye. Henderson has shown that in this case the trouble in orientation is due, not to a lowering of the light sense threshold, but to a suppression of binocular vision. The change from stereoscopic vision is more marked in dim than in bright light.

C. Hemeralopia in pupillary changes. There has been observed a diminution of the light sense in contraction of the pupils, and a corresponding lowering of the threshold in mydriasis. It is therefore advisable to make measurements with the stenopeic aperture, to avoid error due to pupillary changes.

D. Hemeralopia in changes of the lens. As age advances the lens becomes yellowish and fluorescent. As it becomes less clear it absorbs the cold colors of the spectrum. Extraction of the cataractous lens reestablishes blue perception in those patients who had lost it. These observations explain the modifications of color perception in old patients, and the crepuscular amblyopia that may supervene in these cases.

E. Hemeralopia in retinal dazzling. Dazzling may be the determining cause in patients predisposed by disorders in nutrition—it makes manifest a latent retinal deficiency. The phenomenon takes place in the periphery and spares the fovea, and is due to intensity of illumination irrespective of the color of the light. Extractions of a cataract, being sometimes followed by dazzling, may induce hemeralopia.

F. Neuropsychic diseases. The onset of crepuscular amblyopia may be favored by age, the menopause, nervous fatigue and intoxications. These facts should be considered in evaluating hemeralopias due to hysteria or similar afflictions.

III. SYMPTOMATIC HEMERALOPIAS.

These supervene in lesions of the optic tract:

A. Lesions of the optic nerve or chiasm. In addition to impairment of the visual field and diminution of visual acuity, these lesions may be accompanied by: (1) faulty adaptation to low as well as high degrees of illumination, (2) a diminution in the duration of the visual impression together with a concentric contraction of the field and (3) difficulty in adaptation to the variations in intensity of illumination, the crepuscular amblyopia sometimes constituting the most troublesome symptom. All these aberrations, combined under the name "neuroasthenopia," are symptomatic of a primary atrophy when destruction of the afferent fibers is still incomplete.

On the other hand, crepuscular amblyopia may constitute a premonitory symptom of glaucoma, and may also be present in toxic amblyopia, retrobulbar neuritis and papilledema.

B. Hemianopic syndromes. In some cases hemeralopia may appear at the same time as hemianopia, in the form of a special fatigue of the retina. Here the lesion is probably situated at the level of the external geniculate body or in front of it.

After having taken up the etiologic forms of crepuscular amblyopia, the author turns to the pathology of the condition. From his experimental work he has deduced that absence of the fat-soluble vitamin A is an important factor in the production of deficiency hemeralopias and allied conditions.

On the other hand, the crepuscular amblyopia that occurs in the course of jaundice may be provoked by the direct action of the bile, the elements of which are capable of altering the retinal epithelium.

In dealing with crepuscular amblyopia the function of the physician is prophylactic as well as therapeutic. He should discourage marriage in those afflicted by the hereditary forms of the disease. Treatment is dependent on the cause of the condition. The acute deficiency hemeralopias are responsive to treatment with cod liver oil (specific in these cases) and by foods rich in vitamin A. The hepatic forms are

benefited by dried extract of animal liver. Actinotherapy has given interesting results. If syphilis is suspected as the cause, treatment should be undertaken, but the hepatic insufficiency so common in that disease must not be overlooked.

The author has set forth in concise form all the available data on hemeralopia. This excellent monograph is one of the outstanding contributions of the year.

G. M. BRUCE.

BULLETIN OF THE OPHTHALMOLOGICAL SOCIETY OF EGYPT, 1929. Volume 22. Cairo: Misr Press.

The proceedings of the 1929 meeting of the Ophthalmological Society of Egypt are set forth in this bulletin. The articles and discussions deal with a variety of topics.

Of more than average interest is a review of a thesis on trachoma written seventy-five years ago by Mahmoud Younes Effendi, who practiced ophthalmology in Cairo, after being, it is said, the first native doctor to receive training in the eye clinics of Paris. He vigorously combated the fantastic and barbarous therapeutic measures then in vogue, placing his reliance instead on the use of silver nitrate, copper sulphate and scarification. He used belladonna when there was corneal involvement, and practiced paracentesis when corneal perforation impended. This was in 1854.

There follow some rather elementary remarks on the value of the slit-lamp and a none too convincing report on the value of injections of phenolaine for the clearing of corneal nebulae.

An operation for overeversion of the lid is described.

Next, there is an article dealing with bulbar proptosis. Most of the cases are from the Giza Ophthalmic Hospital. They have evidently had the benefit of a wholly modern diagnostic and therapeutic armamentarium. In the series are cases of exophthalmos due to skaphocephaly, orbital cellulitis, ethmoidal and frontal mucoceles and orbital tumors, both malignant and benign. The roentgenograms are unfortunately very poor.

The frequent association of ascaris infection with phlyctenular conjunctivitis is stressed in a short article dealing with the latter disease as studied in Port Said.

Two case histories of perforating injuries are next given. Repeated blood counts were done on these patients and each showed an increase of large mononuclears. In each, however, the eye became quiet under treatment, with no signs of sympathetic disturbance.

Two patients with episcleritis did well on injections of milk.

A case of apparent sympathetic ophthalmia is reported. There is no description of the microscopic examination of the enucleated eye.

A case of multiple fibromata of the lid and forehead is reported, showing the method of excision of the tumors.

There is also an article on the cultural and serologic characteristics of gonococci isolated from cases of conjunctivitis; an article on post-diphtheritic paralysis of accommodation; one on hysterical disorders of the eye, and a table of statistics on trachoma in the Orient.

O. P. PERKINS.

OPHTHALMOLOGY. NOTES FOR STUDENTS. By C. S. O'BRIEN. Price, $2.50. Pp. 370, with outline drawings. Iowa City, Athens Press.

This book was prepared for the use of the author's undergraduate classes in ophthalmology in the University of Iowa Medical School. The commoner pathologic conditions are discussed in a simple, systematic form under the headings etiology, symptoms, diagnosis, prognosis and treatment. No details of operative technic are included, and the discussion of refraction is limited to the simplest principles of optics and a brief description of the common refractive errors. The anatomy of the various parts of the eye and adnexa is summarized in each chapter. The illustrations are outline drawings of the parts, in which the lesions discussed may be drawn by the student, with space for additional notes beneath each. References to standard texts of ophthalmology for more detailed information are given. A chapter of ninety pages on symptom diagnosis is an interesting portion of the book. Here, as in Cabot's "Differential Diagnosis," the common symptoms, such as hyphema, conjunctival chemosis, exophthalmos and vitreous opacities, are listed alphabetically, with the conditions in which each may be found, an arrangement which must often be useful to the student in the diagnosis of the conditions of his dispensary patients, or to the young ophthalmologist. The idea of using such an outline instead of a text, and especially that of the outline drawings, is interesting. The student's own drawings may remain in his memory better than the more finished ones found in a text, and his time during lectures may be better employed by filling in such drawings than by taking copious notes. The low cost of the book makes it possible for the student to procure in addition a more detailed text of ophthalmology which it would seem every medical graduate should have in his library for reference.

S. R. G.

STEREOSKOPISCHER ATLAS DER ÄUSSEREN ERKRANKUNGEN DES AUGES. By PROF. K. WESSELY. Part 2. Price, 12 marks. Munich: J. F. Bergmann, 1930.

Part 2 of this atlas contains colored photographs of no. 11: mottled iris, blepharitis; 12: phlyctenular conjunctivitis; 13: epibulbar dermoid; 14: anterior scleral staphyloma; 15: fistula of tear sac; 16: ulcus serpens; 17: ulcus serpens after cauterization with steam; 18: splinter of iron in the iris; 19: facial herpes with cicatricial entropion; 20 dislocation of the globe.

The lifelike excellence of the stereoscopic photographs in color is as noticeable in this series as in the first and cannot be improved on for teaching purposes.

A. K.

Directory of Ophthalmologic Societies *

FOREIGN

Oxford Ophthalmological Congress

Master: Dr. A. B. Cridland, Salisbury House, Chapel Ash, Wolverhampton, England.
Secretary: Dr. C. G. Russ-Wood, 12 St. John's Hill, Shrewsbury, England.

NATIONAL

American Medical Association, Section on Ophthalmology

Chairman: Dr. George F. Suker, 25 E. Washington St., Chicago.
Secretary: Dr. William C. Finnoff, Imperial Bldg., Denver.
Place: Philadelphia. Time: 1931.

American Academy of Ophthalmology and Oto-Laryngology

President: Dr. William H. Wilder, 122 S. Michigan Ave., Chicago.
President-Elect: Dr. J. F. Barnhill, Miami Beach, Florida.
Executive Secretary: Dr. William P. Wherry, Medical Arts Bldg., Omaha.
Place: Chicago. Time: October 27-31, 1930.

American Ophthalmological Society

President: Dr. Edward C. Ellett, Exchange Bldg., Memphis, Tenn.
Secretary: Dr. Emory Hill, Professional Bldg., Richmond, Va.

SECTIONAL

New England Ophthalmological Society

President: Dr. S. Judd Beach, 704 Congress St., Portland, Maine.
Secretary-Treasurer: Dr. E. B. Dunphy, 520 Commonwealth Ave., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

Pacific Coast Oto-Ophthalmological Society

President: Dr. Arthur Jones, 105 N. 8th St., Boise, Idaho.
Secretary-Treasurer: Dr. Walter F. Hoffman, 817 Summit Ave., Seattle.
Place: Victoria, B. C. Time: September 3-5, 1930.

Puget Sound Academy of Ophthalmology and Oto-Laryngology

President: Dr. Walter F. Hoffman, 817 Summit Ave., Seattle.
Secretary-Treasurer: Dr. Francis A. Brugman, Medical-Dental Bldg., Seattle.
Time: 8 p. m., third Tuesday of each month, except July and August.

Southern Medical Association, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Fred Hasty, 119 Seventh Ave., Nashville, Tenn.
Secretary: Dr. Fletcher D. Woodward, Box 162, University, Va.
Place: Louisville, Ky. Time: November, 1930.

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* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. Wilfrid Haughey, 65 W. Michigan Ave., Battle Creek.
Secretary: Dr. R. H. Fraser, Battle Creek Sanitarium, Battle Creek.
Time: Third Thursday of alternate months.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY

President: A presiding officer is selected for each meeting alternately until all members have served.
Secretary: Dr. Donald H. O'Rourke, 217 Imperial Bldg., Denver.
Place: First floor, Metropolitan Building, Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. Dorland Smith, 836 Myrtle Ave., Bridgeport.
Secretary-Treasurer: Dr. Walter L. Hogan, 750 Main St., Hartford.
Time: May, November.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: W. L. McDougall, 50 Whitehall St., S. W., Atlanta.
Secretary-Treasurer: Dr. William O. Martin, Jr., 384 Peachtree St., Atlanta.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. A. Van Osdol, 320 N. Meridian St., Indianapolis.
Secretary: Dr. Robert J. Masters, 23 E. Ohio St., Indianapolis.
Place: Indianapolis. Time: December 10 and 11, 1930.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. John C. Brown, 350 St. Peter St., St. Paul.
Secretary-Treasurer: Dr. J. H. Morse, 2511 Washburn Ave., S., Minneapolis.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. Lee W. Smith, 125 W. Granite St., Butte.
Secretary: Dr. J. G. Parsons, Lewistown.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. B. Beeson, 232 W. De Mers Ave., Grand Forks.
Secretary-Treasurer: Dr. F. L. Wicks, Valley City.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. J. W. McCollom, 346½ Washington St., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

President: Dr. J. E. Raia, 276 Broadway, Providence, R. I.
Secretary: Dr. F. W. Dimmitt, 195 Thayer St., Providence, R. I.
Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. F. M. McHugh, 17 Exchange Pl., Salt Lake City.
Secretary-Treasurer: Dr. H. Leroy Smith, Ezra Thompson Bldg., Salt Lake City.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. Fletcher D. Woodward, Box 162, University.
Secretary-Treasurer: Dr. Henry Grant Preston, Harrisonburg.

LOCAL

Academy of Medicine of Northern New Jersey, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Frederick J. Wort, 1080 Broad St., Newark.
Secretary: Dr. Earl LeRoy Wood, 31 Lincoln Park, Newark.
Place: 91 Lincoln Park South. Time: 8:45 p. m., second Monday of each month.

Academy of Medicine of Toronto, Section of Ophthalmology

Chairman: Dr. Louis Joseph Sebert, 86 Bloor St., W., Toronto.
Secretary: Dr. Alexander E. MacDonald, 151 Bloor St., W., Toronto.
Time: First Monday of winter months.

Atlanta Academy of Ophthalmology and Oto-Laryngology

President: Dr. William L. McDougall, Atlantic National Bank Bldg., Atlanta, Ga.
Secretary: Dr. William O. Martin, Jr., 384 Peachtree St., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St., N. E. Time: 8 p. m., last Thursday of each month.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. Leo J. Goldbach, 1012 N. Charles St., Baltimore.
Secretary: Dr. Angus Lloyd MacLean, Johns Hopkins Hospital, Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

Brooklyn Ophthalmological Society

President: Dr. John N. Evans, 23 Schermerhorn St., Brooklyn.
Secretary: Dr. Michael J. Buonaguro, 589 Lorimer St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday of February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. A. F. Luhr, 40 W. North Ave., Buffalo.
Secretary-Treasurer: Dr. Thurber Le-Win, 112 Linwood Ave., Buffalo.

Chicago Ophthalmological Society

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Secretary: Dr. Richard C. Gamble, 30 N. Michigan Ave., Chicago.
Place: Medical and Dental Arts Club. Time: Third Monday from October to May.

Cleveland Academy of Medicine, Section of Ophthalmology and Oto-Laryngology

Chairman: Dr. M. Paul Motto, Rose Bldg., Cleveland.
Secretary: Dr. A. D. Ruedemans, Euclid and E. 93d St., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

Cleveland Ophthalmological Club

Chairman: Dr. W. E. Burner, Guardian Bldg., Cleveland.
Secretary: Dr. M. P. Motto, Rose Bldg., Cleveland.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. Maxwell Langdon, 1530 Locust St., Philadelphia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Otolaryngological Society

Chairman: Dr. John E. Brown, 370 E. Town St., Columbus, Ohio.
Secretary-Treasurer: Dr. Albert D. Frost, 681 E. Broad St., Columbus, Ohio.
Time: First Monday of each month.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. H. B. Decherd, 1717 Pacific Ave., Dallas, Texas.
Executive Secretary: Dr. W. Mood Knowles, 1717 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Parker Heath, David Whitney Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. G. G. Marshall, 122 West St., Rutland, Vt.
Secretary-Treasurer: Dr. Arthur F. Holding, 142 Washington Ave., Albany.
Time: Third Wednesday of October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. W. R. Thompson, 510 Main St., Fort Worth, Texas.
Secretary-Treasurer: Dr. R. H. Needham, Fort Worth National Bank Bldg., Fort Worth, Texas.
Place: University Club. Time: 6:30 p. m., first Friday of each month except July and August.

Houston Academy of Medicine, Eye, Ear, Nose and Throat Section

President: Dr. Claude C. Cody, 1306 Walker Ave., Houston, Texas.
Secretary: Dr. J. M. Robison, Eye, Ear, Nose and Throat Hospital, Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., first Thursday of each month from September to June.

Indianapolis Ophthalmological and Oto-Laryngological Society

President: Dr. E. L. Lingeman, 241 N. Pennsylvania St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, Hume-Mansur Bldg., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

Kansas City Society of Ophthalmology and Otolaryngology

President: Dr. A. E. Eubank, Argyle Bldg., Kansas City, Mo.
Secretary: Dr. O. S. Gilliland, Professional Bldg., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

President: Dr. Dean E. Godwin, Security Bldg., Long Beach, Calif.
Secretary-Treasurer: Dr. Ferris Arnold, Security Bldg., Long Beach, Calif.
Place: Pacific Coast Club. Time: Last Wednesday of each month from September to June.

Los Angeles County Medical Society, Section on Ophthalmology and Otolaryngology

President: Dr. A. Ray Irvine, 727 W. 7th St., Los Angeles.
Secretary-Treasurer: Dr. J. Frank Friesen, 727 W. 7th St., Los Angeles.
Place: California Lutheran Hospital, Assembly Room. Time: 8 p. m., first Monday of each month.

Medical Society of the District of Columbia, Section of Ophthalmology and Oto-Laryngology

Chairman: Dr. James A. Flynn, 1511 Rhode Island Ave., Washington.
Secretary: Dr. E. R. Gookin, Medical Science Bldg., Washington.
Place: 1718 M St. N. W. Time: 8 p. m., third Friday of each month.

Memphis Society of Ophthalmology and Oto-Laryngology

Chairman: Each member, in alphabetical order.
Secretary: Dr. R. O. Rychener, Exchange Bldg., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

Milwaukee Oto-Ophthalmic Society

President: Dr. Edward R. Ryan, 425 E. Water St., Milwaukee.
Secretary-Treasurer: Dr. O. P. Schoofs, 120 E. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6:30 p. m., third Tuesday of each month.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. R. J. Warner, 706 Church St., Nashville, Tenn.
Secretary-Treasurer: Dr. W. W. Wilkerson, Jr., Bennie-Dillon Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month.

New Orleans Ophthalmological and Otological Society

President: Dr. W. A. Wagner, Pere Marquette Bldg., New Orleans.
Secretary-Treasurer: Dr. M. F. Meyer, Canal Bank Bldg., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. E. F. Krug, 12 W. 44th St., New York.
Secretary: Dr. William F. C. Steinbugler, 815 Park Ave., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

Omaha and Council Bluffs Ophthalmological and Otolaryngological Society

President: Dr. Charles M. Swab, Medical Arts Bldg., Omaha.
Secretary-Treasurer: Dr. J. C. Davis, 1615 Howard St., Omaha.
Place: Medical Tea Room. Time: 5:15 and 7:00 p. m., third Wednesday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Edward B. Heckel, Jenkins Arcade Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Pittsburgh Slit-Lamp Society

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: 121 University Pl. Time: Second Monday evening of every month, except June, July, August and September.

Rochester Eye, Ear, Nose and Throat Society

Chairman: Dr. A. Vincent Walker, 833 South Ave., Rochester, N. Y.
Secretary-Treasurer: Dr. John F. Gipner, 53 Fitzhugh St., Rochester, N. Y.
Place: Rochester Medical Assn., 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

St. Louis Ophthalmic Society

President: Dr. Charles W. Tooker, 308 N. 6th St., St. Louis.
Secretary: Dr. Carl T. Eber, 1006 Carleton Bldg., St. Louis.
Place: St. Louis or Washington University Cafeteria.
Time: 6:30 p. m., fourth Friday of each month from October to April, inclusive.

San Antonio Ophthalmolo-Oto-Laryngological Society

President: Dr. F. W. Sorrell, Gibbs Bldg., San Antonio, Texas.
Secretary-Treasurer: Dr. A. F. Clark, 728 Main Ave., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

Spokane Academy of Ophthalmology and Otolaryngology

President: Dr. A. N. Codd, 421 W. Riverside Ave., Spokane, Wash.
Secretary: Dr. Marc Anthony, Old National Bank Bldg., Spokane, Wash.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. Searle B. Marlow, State Tower Bldg., Syracuse, N. Y.
Secretary-Treasurer: Dr. A. Harry Rubenstein, Medical Arts Bldg., Syracuse, N. Y.
Place: University Club. Time: Second Friday of each month except June, July and August.